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NOTICE OF INTENT TO PERFORM AN ASSESSMENT AND PREASSESSMENT SCREEN KALAMAZOO RIVER ENVIRONMENT SITE, MICHIGAN

Michigan Department of Environmental Quality
Michigan Department of Attorney General
U.S. Fish and Wildlife Service
National Oceanic and Atmospheric Administration

May 30, 2000

STATE OF MICHIGAN

JOHN ENGLER, Governor

DEPARTMENT OF ENVIRONMENTAL QUALITY

"Better Service for a Better Environment"

HOLLISTER BUILDING, PO BOX 30473, LANSING MI 48909-7973

INTERNET: www.deq.state.mi.us

RUSSELL J. HARDING, Director

REPLY TO

ENVIRONMENTAL RESPONSE DIVISION
KNAPPS CENTRE
PO BOX 30426
LANSING MI 48909-7926

June 2, 2000

Attention: Martha Boetcher
Saugatuck-Douglas Library
10 Mier Street
Douglas, Michigan 49406

Dear Ms. Boetcher:

Enclosed is a copy of the Notice of Intent to Perform an Assessment and Preassessment Screen, Kalamazoo River Environmental Site, Michigan, dated May 30, 2000. Please add it to your collection for the Allied Paper, Inc./Kalamazoo River/Superfund Site.

Please return the enclosed fax transmittal form to confirm your receipt of this letter and document. Thank you.

Sincerely,

Anne Pulley

Anne Pulley
Environmental Response Division
517-335-6690

Enclosures

EQP 0100e
(Rev 1/98)

May 18, 2000

CERTIFIED MAIL

Ms. Kathleen Bennett
V.P. Environment Hazardous Substances
Fort James Corporation
1650 Lake Cook Road
Deerfield, Illinois 60015

Ms. Susan Moore
V.P. of Environmental Affairs
Georgia Pacific Corporation
7016 A.C. Skinner Parkway
Jacksonville, Florida 32256

Mr. William Boyden
Senior V.P. of Operations
Specialty Paper Division
Plainwell, Inc.
200 Allegan Street
Plainwell, Michigan 49080

Mr. Samuel Friedman
V.P. and General Council
Millenium Holdings, Inc.
230 Half Mile Road
Red Bank, New Jersey 07701

Dear Ms. Bennett, Mr. Boyden, Ms. Moore, and Mr. Friedman:

SUBJECT: Notice of Intent to Perform a Natural Resource Damage Assessment for the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Pursuant to state and federal laws, the Michigan Department of Environmental Quality, the Michigan Department of Attorney General, the U.S. Department of the Interior and the U.S. Department of Commerce (collectively, Trustees) have natural resource trustee authority to perform a natural resource damage assessment for the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund site. This site includes the Kalamazoo River from Morrow Pond Dam to Lake Michigan and Portage Creek from just upstream of Allied Paper, Inc. facilities to the creek mouth. Each agency's specific authority to act in this capacity is specified in Attachment A.

The Michigan Department of Environmental Quality, the Michigan Department of Attorney General, and the U.S. Department of the Interior; in consultation with the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, have taken the initial step of conducting a Preassessment Screen for this site in accordance with the U.S. Department of the Interior (USDOI) Natural Resource Damage Assessment (NRDA) Regulations, 43 C.F.R. §§ 11.10 et seq. These USDOI NRDA Regulations govern the assessment of natural resource damages resulting from a release of a hazardous substance under the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended (CERCLA)(42 U.S.C. §§ 9601 et seq.). We are forwarding a copy of our Preassessment Screen for your information (Attachment B).

We have also elected to provide the Preassessment Screen to the public for its information. We intend to provide the Kalamazoo River Study Group (KRSG) an opportunity to participate in the NRDA process by providing comments to the Trustees on the Assessment Plan, prior to the Trustees implementing the Assessment Plan to be developed pursuant to the USDOI NRDA Regulations. The public will also be encouraged to provide input to the assessment process.

Based on the Preassessment Screen, the Trustees have made a preliminary determination that all of the following criteria specified in Section 11.23(e) of the USDOI NRDA Regulations have been met:

1. A discharge of oil or a release of a hazardous substance has occurred.

2. Natural resources for which the federal or state agency or Indian tribe may assert trusteeship under CERCLA have been or are likely to have been adversely affected by the discharge or release.

3. The quantity and concentration of the discharged oil or released hazardous substance is sufficient to potentially cause injury, as that term is used in this part, to those natural resources.

4. Data sufficient to pursue an assessment are readily available or likely to be obtained at reasonable cost.

5. Response actions, if any, carried out or planned do not or will not sufficiently remedy the injury to natural resources without further action.

Based on evaluation of these five criteria, the Trustees have determined that a NRDA should be carried out at this site in accordance with subparts C and E of the USDOI NRDA Regulations, in order to assess damages to natural resources caused by releases of polychlorinated biphenyls from potentially responsible party facilities in the Kalamazoo River basin.

The Trustees have also made a preliminary determination that your company, as well as the other companies listed in Attachment C, are potentially liable for any natural resource damages at the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund site. For more information on the background of this Superfund site and the basis of the preliminary determination, please refer to the Preassessment Screen (Attachment B).

This is the Notice of Intent to Perform an Assessment inviting your participation in the development and performance of the assessment pursuant to Section 11.32(a)(2)(iii)(A) of the USDOI NRDA Regulations for the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund site, as further described in the Preassessment Screen.

Within thirty (30) calendar days of your receipt of this notice, please provide a response to each of the Trustee contacts in Attachment D, indicating whether you intend to participate in the NRDA process at the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund site.

Date 5/24/00

Russell J. Harding, Director
Michigan Department of Environmental Quality

Date 5/31/00

Jennifer M. Granholm, Attorney General
State of Michigan

Date 5/23/00

William Hartwig, Regional Director
Region 3
U.S. Fish and Wildlife Service
U.S. Department of the Interior

Attachments

ATTACHMENT A

Michigan Departments of Environmental Quality and Attorney General Natural Resource Damage Assessment Authority

The Michigan Department of Environmental Quality (MDEQ) is responsible for administering environmental regulatory programs for the State of Michigan. The Michigan Department of Attorney General (MDAG) is responsible for enforcing environmental laws within the State of Michigan. Pursuant to Section 20126a(1)(c) of Part 201, Environmental Remediation, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA), as well as Section 3115(2) of Part 31, Water Resources Protection, of NREPA, persons who are liable are jointly and severally liable for the full value of injuries to natural resources. The Director of the MDEQ and the Attorney General of the State of Michigan have also been designated by Michigan's Governor, John Engler, as Trustee and Co-Trustee, respectively, for state natural resources pursuant to Section 107(f)(2)(B) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA), 42 U.S.C. §§ 9601 et seq., and Section 311 of the Federal Water Pollution Control Act of 1972, as amended (Clean Water Act), 33 U.S.C. §§ 1251 et seq. Please see the attached February 6, 1996 letter from Governor Engler to Ms. Carol Browner, Administrator of the U.S. Environmental Protection Agency.

U.S. Department of the Interior and U.S. Department of Commerce Natural Resource Damage Authority

The CERCLA and the Clean Water Act authorize the President to recover, on behalf of the public, damages for injuries to natural resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States. 42 U.S.C. §§ 9607(f)(1), 9601(16); 33 U.S.C. § 1321(f)(5). The President has designated federal natural resource trustees in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 C.F.R. § 300.600. The NCP states that federal natural resource trusteeship extends to resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled (referred to as "managed or controlled") by the United States, including supporting ecosystems resources, 40 C.F.R. § 300.600.

The Secretary of the Interior acts as trustee for natural resources managed or controlled by the U.S. Department of the Interior (USDOI), including their supporting ecosystems, 40 C.F.R. § 300.600(b), (b)(2), and (b)(3). Pursuant to the Fish and Wildlife Coordination Act, 16 U.S.C. §§ 661 et seq., and the Fish and Wildlife Act, 16 U.S.C. §§ 742a et seq., the United States, in part through USDOI, manages and/or controls all natural resources regulated under the Clean Water Act.

The Secretary of Commerce acts as trustee for natural resources managed or controlled by the U.S. Department of Commerce (USDOC), including their supporting ecosystems. 40 C.F.R. § 300.600(b), (b)(1). Pursuant to the Great Lakes Critical Programs Act of 1990, 33 U.S.C. § 1268 (Great Lakes Act), and the Great Lakes Water Quality Agreement of 1978, as amended by the Water Quality Agreement of 1987 (Great Lakes Water Quality Agreement), the United States, in part through USDOC, manages and/or controls the water and sediments of the Great Lakes System. The water and sediments of the Kalamazoo River and Lake Michigan fall within the Great Lakes System.

STATE OF MICHIGAN
OFFICE OF THE GOVERNOR
LANSING

JOHN ENGLER
GOVERNOR

February 6, 1996

Ms. Carol Browner, Administrator
U.S. Environmental Protection Agency
401 M Street, SW
Washington, D.C. 20460

Dear Administrator Browner:

Pursuant to Section 311 of the federal Water Pollution Control Act, Section 1006 of the Oil Pollution Act and Section 107 of the Comprehensive Environmental Response, Compensation and Liability Act, I am designating the Director of the Michigan Department of Environmental Quality (MDEQ) as the lead trustee for the State of Michigan to conduct assessments of natural resource damages that may result from the release of oil or a hazardous substance to the environment. Currently, Mr. Russell J. Harding serves as the Director of the MDEQ. In addition, I have asked Michigan Attorney General Frank J. Kelley to serve as co-trustee to seek equitable relief or damages under law for injury to, destruction of or loss of natural resources.

It is my intent that this designation will facilitate a coordinated and cooperative effort between the State of Michigan and the United States to ensure the appropriate assessment, restoration, replacement and/or acquisition of equivalent alternatives of the injured or lost natural resources.

We look forward to working with the U.S. Environmental Protection Agency and the designated federal trustees toward protecting and preserving the outstanding natural resources of Michigan and the Great Lakes Basin. Please feel free to contact the MDEQ directly to discuss the respective roles of natural resource trustees of Michigan.

Sincerely,

John Engler

John Engler
Governor

JE/ls

cc: The Honorable Frank Kelley, Attorney General
Mr. Russell J. Harding

ATTACHMENT C

List of Potentially Liable Parties/Addressees

Ms. Kathleen Bennett
V.P. Environment Hazardous Substances
Fort James Corporation
1650 Lake Cook Road
Deerfield, Illinois 60015

Ms. Susan Moore
V.P. of Environmental Affairs
Georgia Pacific Corporation
7016 A.C. Skinner Parkway
Jacksonville, Florida 32256

Mr. William Boyden
Senior V.P. of Operations
Specialty Paper Division
Plainwell, Inc.
200 Allegan Street
Plainwell, Michigan 49080

Mr. Samuel Friedman
V.P. and General Council
Millenium Holdings, Inc.
230 Half Mile Road
Red Bank, New Jersey 07701

ATTACHMENT D

Primary Contacts for the Trustees

Michigan Department of Environmental Quality
Mr. Dennis A. Armbruster
Assistant Division Chief
Surface Water Quality Division
Michigan Department of Environmental Quality
P.O. Box 30273
Lansing, Michigan 48909-7773

Michigan Department of Attorney General
Mr. Neil Gordon
Assistant Attorney General
Natural Resources Division
Michigan Department of Attorney General
300 South Washington Square, Suite 315
Lansing, Michigan 48913

United States Department of the Interior
Dr. Lisa Williams
U.S. Fish and Wildlife Service
2651 Coolidge Road
East Lansing, Michigan 48823

United States Department of Commerce
Mr. Todd Goeks
Coastal Resource Coordinator, SRT-4J
Hazardous Materials Response and Assessment Division
National Oceanic Atmospheric Administration
U.S. Department of Commerce
77 West Jackson Boulevard
Chicago, Illinois 60604

PREASSESSMENT SCREEN

KALAMAZOO RIVER ENVIRONMENT SITE, MICHIGAN

Michigan Department of Environmental Quality
Michigan Department of Attorney General
U.S. Fish and Wildlife Service
National Oceanic and Atmospheric Administration

Prepared by:
Stratus Consulting Inc.
1881 9th Street, Suite 201
Boulder, CO 80302

Under Subcontract to:
DLZ Corporation

May 30, 2000

CONTENTS

FIGURES

TABLES

ACRONYMS

Ah	aryl hydrocarbon
AWQC	ambient water quality criteria
BMP	Bryant Mill Pond
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CWA	Clean Water Act
DEQ	Department of Environmental Quality
DNR	Department of Natural Resources
DPH	Department of Public Health
HRDL	historical residuals dewatering lagoon
KRE	Kalamazoo River environment
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
NPL	National Priorities List
NRDA	natural resource damage assessment
OU	operable unit
PCB	polychlorinated biphenyl
PRP	potentially responsible party
RI/FS	remedial investigation/feasibility study
ROD	Record of Decision
SDWA	Safe Drinking Water Act
SEC	sediment effects concentration
U.S. DOI	United States Department of the Interior
U.S. EPA	United States Environmental Protection Agency
WWTP	wastewater treatment plant

EXECUTIVE SUMMARY

S.1 INTRODUCTION

This document contains the Preassessment Screen for the Kalamazoo River Environment (KRE) natural resource damage assessment (NRDA) being performed jointly by the Director of the Michigan Department of Environmental Quality, the Attorney General of the State of Michigan, and the Regional Director of the U.S. Fish and Wildlife Service, in coordination with the Secretary of Commerce as represented by the National Oceanic & Atmospheric Administration (collectively, the Trustees). The Preassessment Screen documents the Trustees' conclusion, based on a "rapid review of readily available information that focuses on resources for which the Federal or State agency or Indian tribe may assert trusteeship," that there is a reasonable probability of making a successful claim for natural resource damages [43 CFR § 11.23(b)]. This document was prepared by Stratus Consulting Inc. under DLZ Corporation's prime contract to the Michigan Department of Environmental Quality (DEQ).

S.2 BACKGROUND

Polychlorinated biphenyls (PCBs) have been released to the KRE by industrial activities in the vicinity of Kalamazoo, Michigan. As a result, on August 30, 1990, the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site was included on the National Priorities List (NPL) pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 U.S.C. §§ 9601 *et seq.*, as amended. On December 28, 1990, the State of Michigan entered into an Administrative Order by Consent (the Order) with Allied Paper, Inc. and its parent company, Millennium Holdings, Inc. (formerly HM Holdings); the Georgia-Pacific Corporation; and Plainwell Inc. (formerly the Simpson Plainwell Paper Company). Pursuant to the Order, these companies are undertaking a remedial investigation/feasibility study (RI/FS). In addition, the Fort James Corporation (formerly the James River Corporation) is participating in the RI/FS, although it is not a party to the Order.

The Trustees have begun to assess the natural resource damages resulting from releases of hazardous substances to the KRE in accordance with the NRDA regulations set forth at 43 CFR Part 11.[1] These regulations are not mandatory. However, a NRDA performed in compliance with these regulations has the force and effect of a rebuttable presumption in any administrative or

1. 43 CFR Part 11 regulations were authored by the U.S. Department of the Interior (DOI), and are referred to as the U.S. DOI regulations in this document.

judicial proceeding under CERCLA [42 U.S.C. § 9607 (f)(2)(C)]. The first step in the process established by U.S. DOI is preparation of a preassessment screen, which is intended to be a "rapid review of readily available information" to ensure that there is a reasonable probability of making a successful natural resource damages claim [43 CFR § 11.23(b)].

S.3 PREASSESSMENT SCREEN EVALUATION CRITERIA

The U.S. DOI regulations establish five evaluation criteria, which must all be met, for the Preassessment Screen [43 CFR § 11.23(e)]. These five criteria and a brief summary of information readily available to the State of Michigan that supports these criteria are presented below. Citations for the information presented in the following summary are in the body of this document.

1. Releases of hazardous substances have occurred.

- Releases of the hazardous substance PCBs [Table 302.4 at 40 CFR § 302.4] from potentially responsible party (PRP)[2] facilities in the KRE have been well documented. The PRPs that have been identified as having contributed to PCB releases include Allied Paper, Inc. and its parent company, Millennium Holdings, Inc.; the Georgia-Pacific Corporation; Plainwell Inc.; and the Fort James Corporation. Numerous investigators, including the Michigan Water Resources Commission, the Michigan Department of Natural Resources (DNR),[3] Georgia-Pacific, and various contractors have demonstrated that multiple, and at times continuous, releases and re-releases of PCBs have occurred and continue to occur as a result of operations at paper facilities owned and operated by the PRPs.

- PCBs were prevalent in recycled paper streams from the mid-1950s to the mid-1970s. The deinking, repulping, and use of recycled paper stock led to PCB releases from PRP facilities into the KRE. Evidence of PCB releases from PRP facilities includes direct effluent releases from PRP facilities, known bypasses of waste treatment facilities at PRP facilities in the 1960s, and PCB contamination in PRP landfills and in groundwater at the landfills. Furthermore, the presence of PCBs throughout the KRE downstream of PRP facilities, including an estimated

2. The term PRP as used in this document refers to parties potentially liable for natural resource damages under CERCLA and/or under Part 201 of the Michigan Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

3. Pursuant to State of Michigan Executive Order 1995-18, on October 1, 1995 the division of the Michigan DNR that has responsibility for the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site RI/FS and the KRE NRDA was transferred to the Michigan DEQ (which was created by this Executive Order).

103,400 kilograms (228,000 pounds) of PCBs in depositional areas of river sediments and floodplain soils, is additional evidence that PCB releases have occurred.

2. **Natural resources for which the Trustees can assert trusteeship have been, or are likely to be, adversely impacted by the release.**

   - Natural resources under the trusteeship of the Trustees that have been affected or potentially affected by releases of hazardous substances from the PRP facilities include, but are not limited to, surface water resources, including surface water and sediments (bed, bank, and shoreline) of Portage Creek and the Kalamazoo River; groundwater resources; geologic resources, including floodplain soils adjacent to Portage Creek and the Kalamazoo River; aquatic biota, including aquatic invertebrates and resident and migratory fish; and terrestrial biota, including terrestrial invertebrates, mammals, and birds.

3. **The quantity and concentration of the released substances are sufficient to potentially cause injury to those natural resources.**

   Numerous investigations over the last 28 years have documented elevated levels of PCBs that are sufficient to potentially cause injury to KRE natural resources.

Surface Water/Sediments

▸ Surface water resources are potentially injured when concentrations of a released hazardous substance exceed (1) relevant federal or state water quality criteria or standards, including U.S. Environmental Protection Agency (U.S. EPA) ambient water quality criteria (AWQC) [43 CFR § 11.62(b)(1)(i), (ii), (iii)]; or (2) concentrations sufficient to have caused injury to groundwater, air, geologic, or biological resources when those resources are exposed to surface water resources [43 CFR § 11.62(b)(1)(v)]. Review of existing data indicates the following:

   - In 1993, 21 of 24 Portage Creek surface water samples from downstream of PRP facilities that release PCBs exceeded multiple state and federal surface water criteria or standards. For example, the maximum concentration measured, 0.23 μg/L, exceeded the chronic AWQC by an order of magnitude and the Michigan Water Quality Standard value of 2.6×10^{-5} μg/L by four orders of magnitude.

   - Between 1985 and 1987, the Michigan DNR collected 27 water samples in Portage Creek downstream of PRP facilities. PCB concentrations in all 27 samples exceeded multiple state and federal surface water criteria or standards.

- Between 1985 and 1987, PCB concentrations exceeded the U.S. EPA chronic AWQC in 56 of 79 surface water samples (71%) collected from the Kalamazoo River downstream of PRP facilities (Figure S-1).

- PCB concentrations in Portage Creek sediments have exceeded the 0.4 mg/kg mid-range sediment effect concentration and the 1.7 mg/kg extreme effect concentration that were developed using a consensus-based approach from existing sediment quality criteria and guidelines. These sediment effect concentrations are intended to indicate the potential for sediment PCBs to cause toxicity to benthic invertebrates. PCB concentrations as high as 369 mg/kg have been measured in Portage Creek sediments.

- PCB concentrations in Kalamazoo River sediments have also exceeded the mid-range and extreme effect concentrations (Figure S-2). Sediment PCB concentrations at some locations have exceeded the 1.7 mg/kg extreme effect concentration by an order of magnitude or greater, including 180 mg/kg in sediments near the Otsego Dam, 67 mg/kg near Plainwell, 48 mg/kg downstream of Georgia-Pacific, and 42 mg/kg in Lake Allegan.

Based on this review of available information, KRE surface water resources are potentially injured as a result of PCB releases.

Soils

- Floodplain soils are injured when PCB concentrations are sufficient to cause injury to other resources when exposed to the soil [43 CFR § 11.62(e)]. Review of available information indicates that:

  - Prior to removal, floodplain soils along Portage Creek downstream of PRP facilities contained PCBs at concentrations well in excess of the 1 mg/kg concentration estimated by the U.S. DOI to result in adverse effects to terrestrial biota. Maximum PCB concentrations at the former Bryant Mill Pond impoundment were as high as 1000 mg/kg.

  - Floodplain soils along the Kalamazoo River also contain PCBs at concentrations greater than 1 mg/kg (Figure S-3). Floodplain soils from three former impoundments (Plainwell, Otsego, and Trowbridge) collected in 1993 contained PCB concentrations as high as 85 mg/kg, 36 mg/kg, and 81 mg/kg, respectively. For comparison, floodplain soils collected along the Kalamazoo River upstream of PRP facilities in 1993 contained a range of PCB concentrations from below a detection level of 0.11 mg/kg to 0.39 mg/kg.

Figure S-1
Percent of Surface Water Samples Collected from the Kalamazoo River between 1985 and 1987 that Exceed the Chronic AWQC

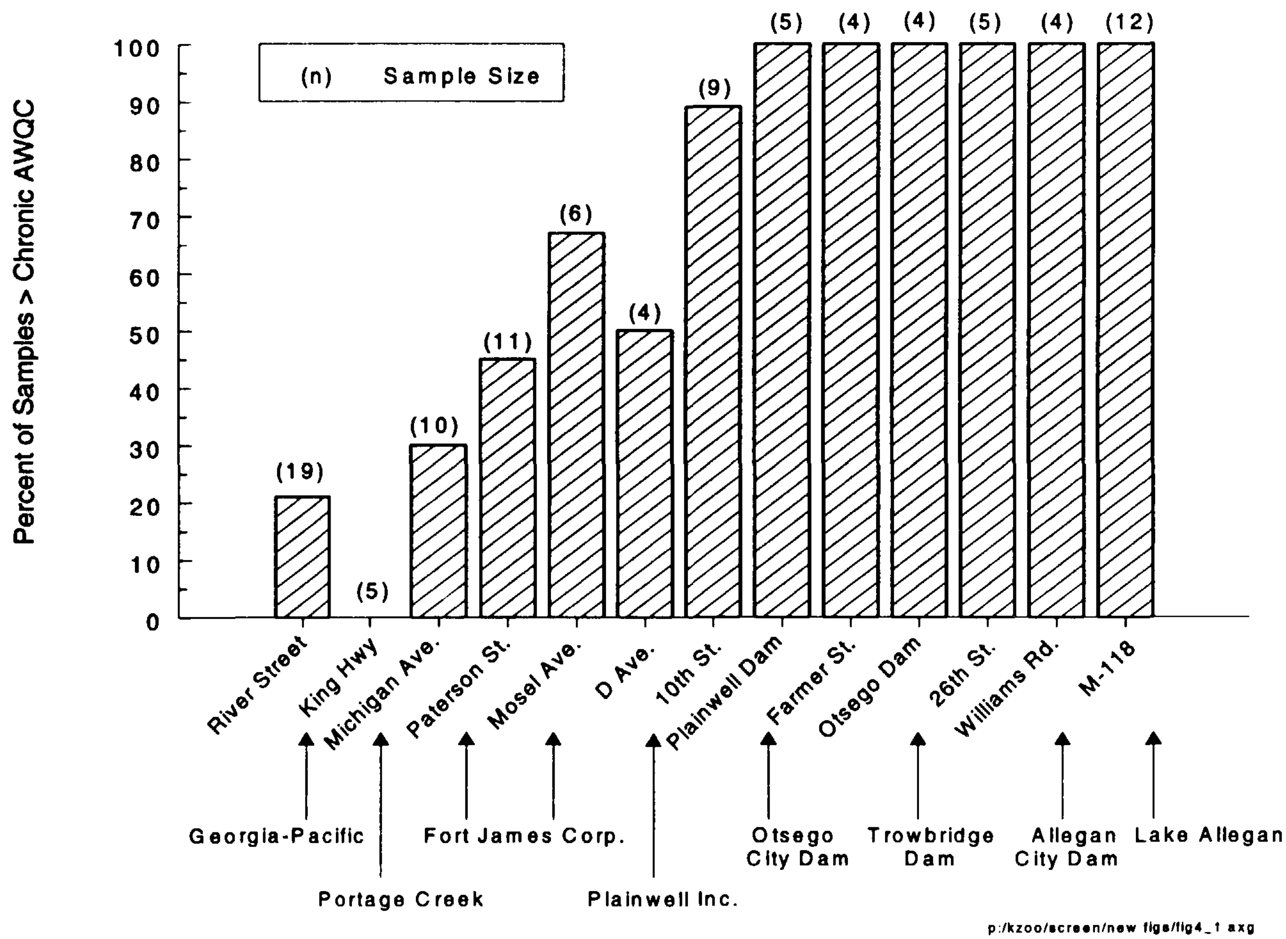


Figure S-2
Percent of Kalamazoo River Bed Sediment Samples Collected between 1976 and 1993 that Exceed the SEC of 1.7 mg/kg PCBs

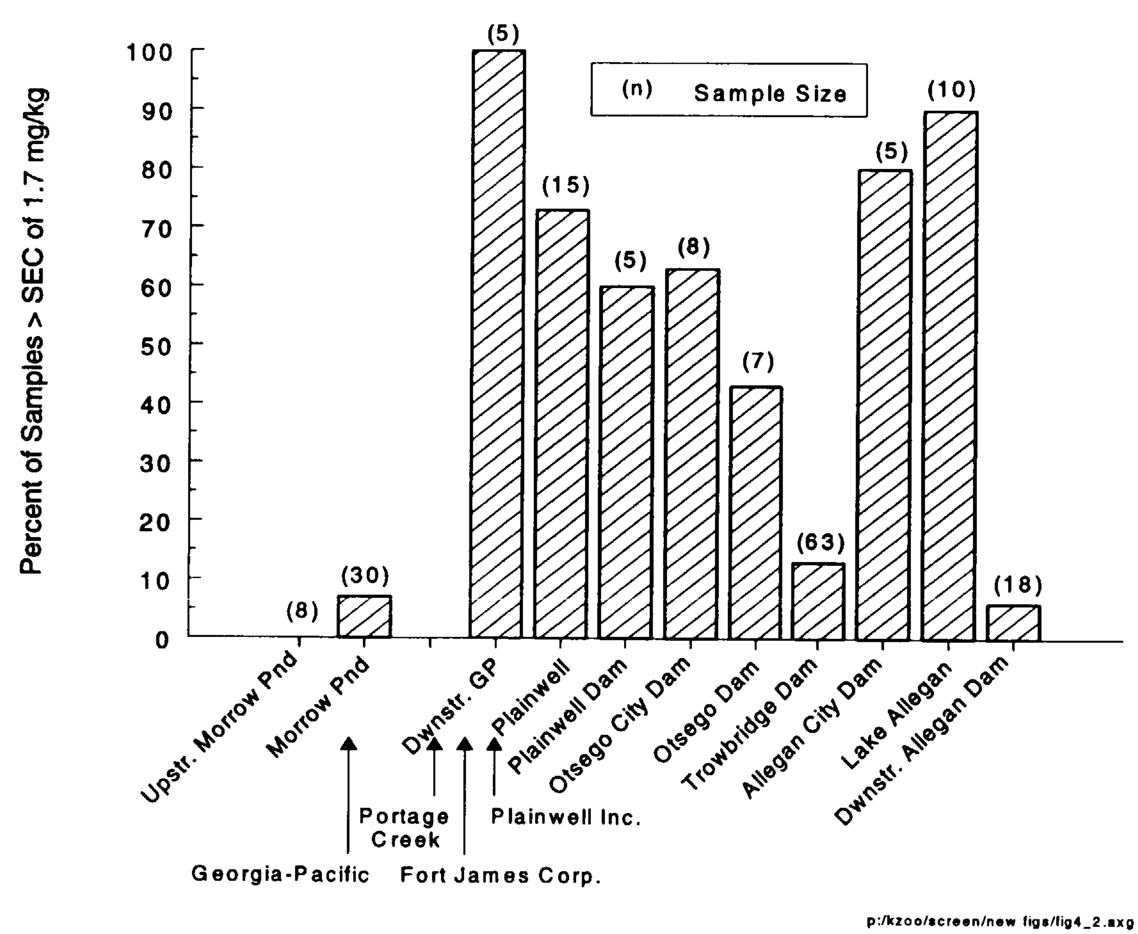
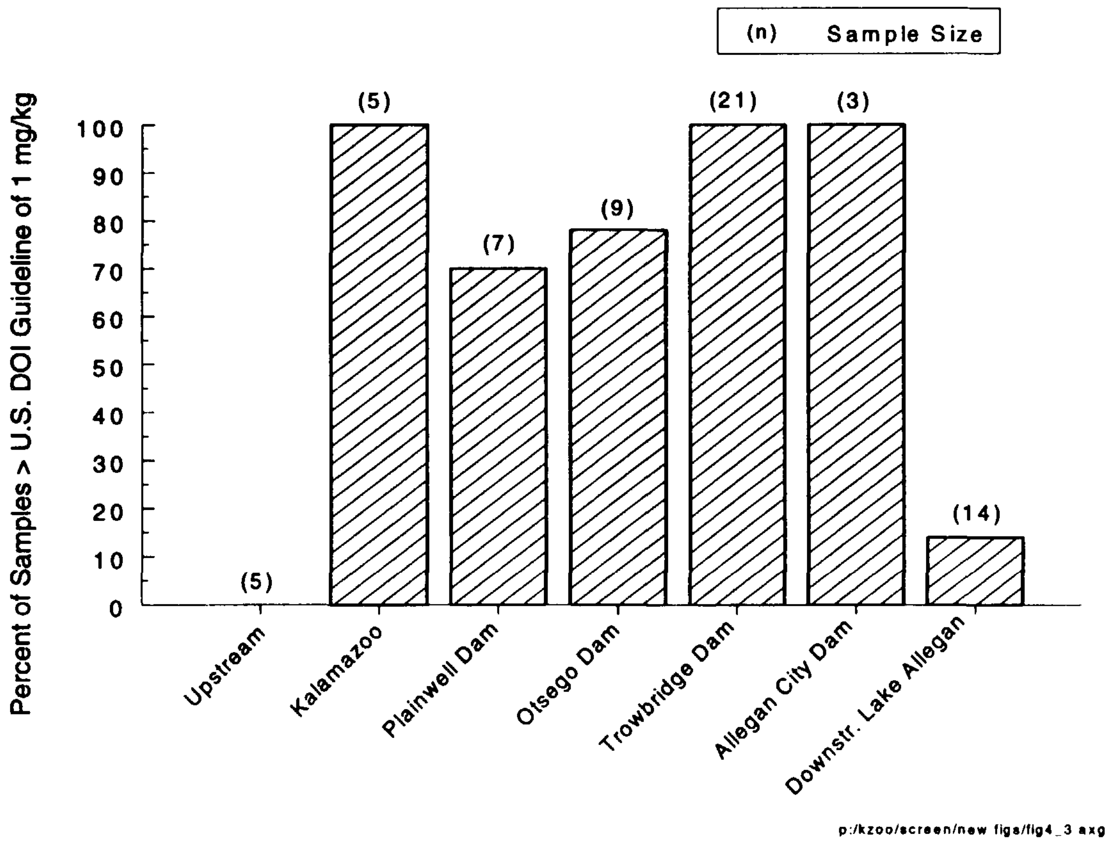


Figure S-3
Percent of Kalamazoo River Floodplain Soil Samples Collected between 1983 and 1989 that Exceed the U.S. DOI Guidelines



Based on this review of available information, KRE soil resources are potentially injured as a result of PCB releases.

Groundwater

- Groundwater resources are potentially injured when PCB concentrations exceed applicable Safe Drinking Water Act (SDWA) standards or criteria [43 CFR § 11.62(c)(1)(i), (ii)], applicable water quality criteria [43 CFR § 11.62(c)(1)(iii)], or concentrations sufficient to cause injury to other resources when exposed to groundwater [43 CFR § 11.62(c)(1)(iv)]. Review of available information indicates the following:

  - Groundwater samples near the Allied Paper facilities adjacent to Portage Creek contain PCBs at concentrations as high as 3.3 μg/L, 2.1 μg/L, and 0.56 μg/L. These concentrations exceed the SDWA Maximum Contaminant Level for PCBs of 0.5 μg/L and the Maximum Contaminant Level Goal of 0 μg/L established under Section 1416 of the SDWA [56 FR 3594]. In contrast, groundwater samples from areas upgradient of PRP facilities contain less than 0.01 μg/L PCBs.

Based on this review of available information, KRE groundwater resources are potentially injured as a result of PCB releases.

Fish

- Fishery resources are injured when PCB concentrations are sufficient to: exceed action or tolerance levels established under Section 402 of the Food, Drug and Cosmetic Act (21 U.S.C. 342) in edible portions of fish [43 CFR § 11.62(f)(1)(ii)]; exceed levels for which an appropriate state health agency has issued directives to limit or ban consumption of fish [43 CFR § 11.62(f)(1)(iii)]; or cause fish or their offspring to have undergone at least one of the following adverse changes in viability: death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), or physical deformations [43 CFR § 11.62(f)(1)(i)]. Review of available information indicates the following:

  - A 1993 study in Portage Creek showed that the mean fillet PCB concentration in carp (*Cyprinus carpio*) exposed to PCBs downstream of PRP facilities was greater than the 2.0 mg/kg tolerance level for PCBs in edible fish tissue established by Section 402 of the Food, Drug and Cosmetic Act (21 U.S.C. 342) and the State of Michigan. The maximum fillet PCB concentration was 8.8 mg/kg, more than four times greater than the tolerance level. In 1993, 82% of the carp collected from Portage Creek downstream of PRP facilities contained fillet PCB concentrations equal to or greater than 2.0 mg/kg.

- In the Kalamazoo River, more than 75% (75 of 99) of carp fillets (Figure S-4) and more than 26% (26 of 99) of smallmouth bass (*Micropterus dolomieui*) fillets collected in 1993 downstream of PRP facilities contained PCBs in excess of 2.0 mg/kg. PCB concentrations in carp fillets were as high as 17 mg/kg, over eight times greater than the 2.0 mg/kg tolerance level. PCB concentrations in smallmouth bass fillets were as high as 5.8 mg/kg, approximately three times greater than the 2.0 mg/kg tolerance level.

- In 1987, of the 12 species collected from the KRE and examined for PCBs, fillets from six species [channel catfish (*Ictalurus punctatus*), carp, northern pike (*Esox lucius*), smallmouth bass, largemouth bass (*Micropterus salmoides*), and white sucker (*Catostomus commersoni*)] contained PCB concentrations that equaled or exceeded the 2.0 mg/kg tolerance level.

- PCBs have been measured in adult fish at concentrations that exceed levels expected to cause reproductive impairment injuries. Predicted PCB concentrations in eggs of KRE fish exceed concentrations shown to cause adverse reproductive effects in studies conducted on fish.

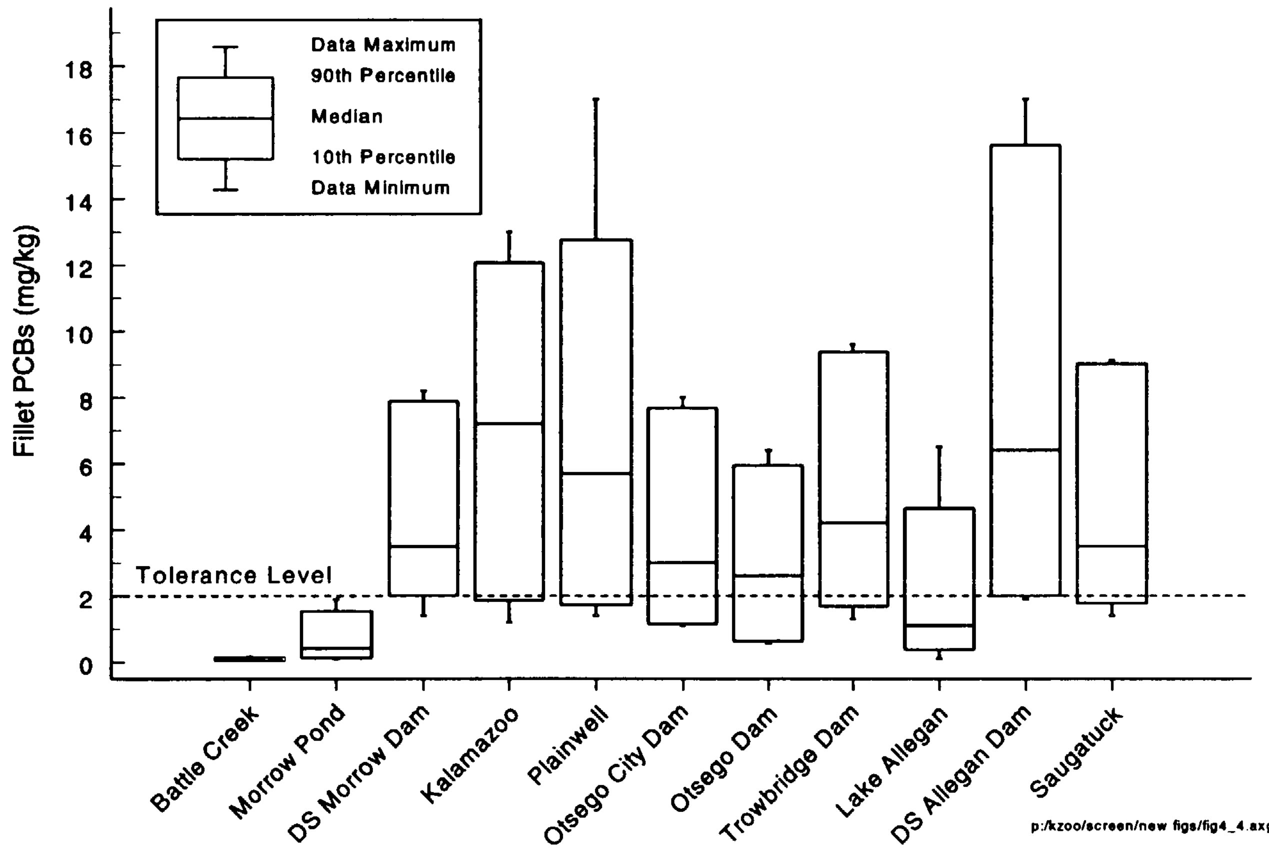
Based on this review of available information, KRE fishery resources are potentially injured as a result of PCB releases.

Wildlife

- Wildlife resources are injured when PCB concentrations in edible tissue exceed action or tolerance levels established under Section 402 of the Food, Drug and Cosmetic Act (21 U.S.C. 342) in edible portions of fish [43 CFR § 11.62(f)(1)(ii)]; exceed levels for which an appropriate state health agency has issued directives to limit or ban consumption [43 CFR § 11.62(f)(1)(iii)]; or cause wildlife or their offspring to have undergone at least one of the following adverse changes in viability: death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), or physical deformations [43 CFR § 11.62(f)(1)(i)]. Review of available data indicates the following:

  - PCB concentrations measured in waterfowl in the KRE have exceeded the tolerance level of 3 mg/kg in poultry fat or red meat fat established by Section 402 of the Food, Drug and Cosmetic Act (21 U.S.C. 342) in 14 of 15 mallards (*Anas platyrhynchos*) sampled, 1 of 2 wood ducks (*Aix sponsa*) sampled, and in each of the single individuals sampled for the following species: Canada goose (*Branta canadensis*), merganser (*Mergus* spp.), and blue-winged teal (*Anas discors*).

Figure S-4
PCB Concentrations in Kalamazoo River Skinless Carp Fillets Measured in 1993 Compared with the Federal and State Tolerance Level for PCBs in Fish Tissue



Downstream is to the right. Battle Creek and Morrow Pond locations are upstream of PRP facilities. The horizontal dotted line is the FDA tolerance and State fish consumption advisory action level of 2 mg/kg. Sample size at all sites is 11 carp.

- Whole-body PCB concentrations in fish collected in 1993 from Portage Creek and the Kalamazoo River were well above the concentration estimated to cause adverse effects to mink (*Mustela vison*) via dietary intake (Figure S-5).

- PCB concentrations in the livers of mink collected in 1993 from areas downstream of paper company facilities exceeded concentrations shown to be associated with increased mortality and adverse reproductive effects.

- Whole-body PCB concentrations in Kalamazoo River fish exceed the 5 mg/kg PCB concentration associated with adverse effects on fish-eating birds, including decreased hatching success, decreased fertility, and decreased chick growth (Figure S-5). One to two pairs of bald eagles (*Haliaeetus leucocephalus*), which consume fish as a large portion of their diets, have attempted to nest along the Kalamazoo River downstream of paper companies for the past 10 years. Except for eggs from one of the nests in 1998 and another nest in 1999, none of the eggs from those nests have hatched successfully.

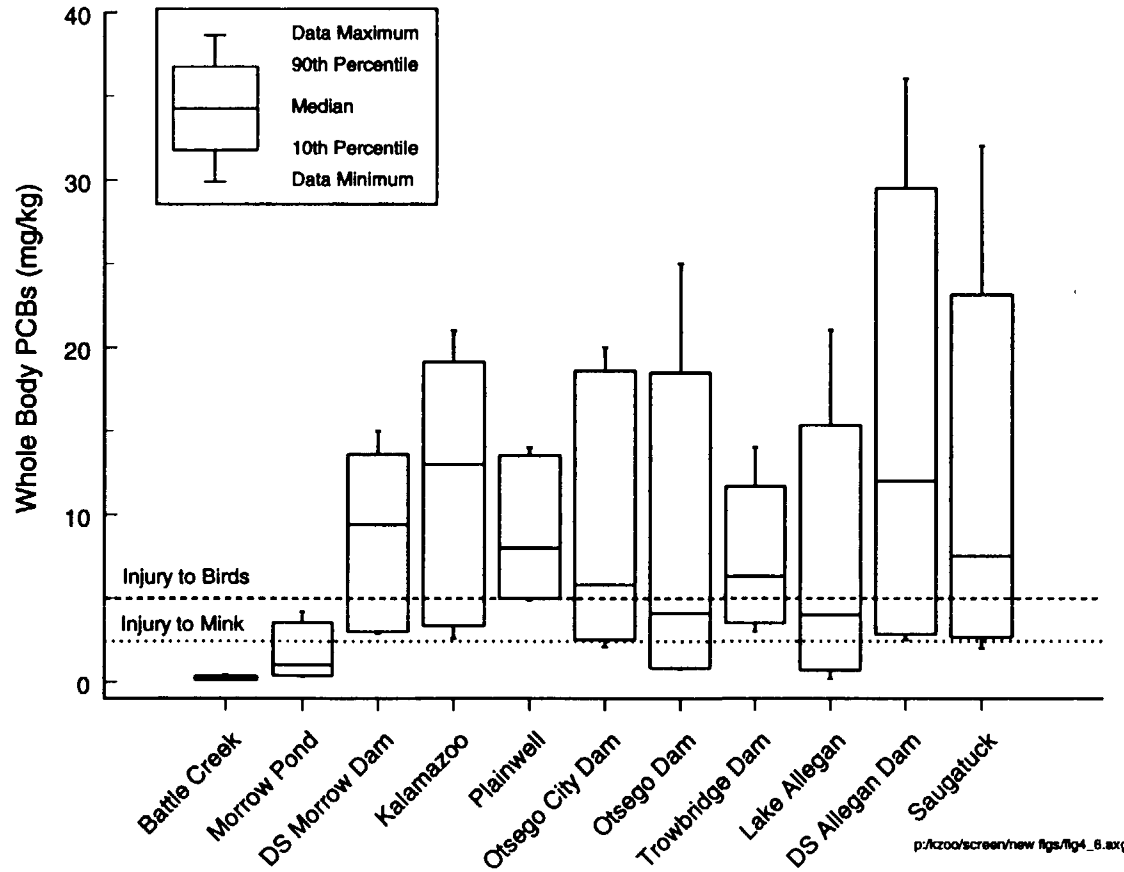
- PCB concentrations measured in the eggs of several predatory bird species collected in the KRE at and downstream of paper company facilities exceed concentrations reported to cause adverse effects in laboratory and field studies. For example, a single bald eagle egg (which did not hatch) collected in 1994 from a nest near Lake Allegan contained 102 mg/kg PCB, two orders of magnitude greater than concentrations associated with adverse effects. PCB concentrations measured in 1993 and/or 1994 in the eggs of great blue herons (*Ardea herodias*), great horned owls (*Bubo virginianus*), and red-tailed hawks (*Buteo jamaicensis*) also exceeded concentrations associated with adverse effects, as did concentrations in the eggs of bald eagles collected in 1996.

Based on available information, KRE wildlife resources are potentially injured as a result of PCB releases.

4. **Data sufficient to pursue an assessment are readily available or likely to be obtained at reasonable cost.**

   Data relevant to conducting an assessment of natural resource damages in the KRE have been collected as part of ongoing RI/FS activities. Such data include information on PCB sources, releases, pathways, and concentrations in the environment. As the Preassessment Screen is intended only to determine whether there is sufficient cause to pursue an NRDA, omission of any of this or other information in the Preassessment Screen does not preclude consideration of such information in the course of an NRDA. Additional data for the purposes of performing a damage assessment are expected to be obtainable at reasonable cost.

Figure S-5
Whole-Body PCB Concentrations in Kalamazoo River Carp Measured in 1993 Compared with Concentrations Sufficient to Potentially Cause Injury to Piscivorous Wildlife



Downstream is to the right. Battle Creek and Morrow Pond locations are upstream of PRP facilities. Sample size at all sites is 11 carp.

5. **Response actions carried out or planned will not sufficiently remedy the injury to natural resources without further action.**

   PCBs degrade slowly and are persistent in the environment. Available data indicate that surface water, sediments, soils, and biological resources throughout the KRE at and downstream of PRP facilities are contaminated with PCBs. Response actions being formulated as part of the RI/FS most likely will not restore to baseline the injured natural resources or the sources they provide or address past losses of natural resource services.

In summary, the Trustees find that multiple and at times continuous releases and re-releases of PCBs into the KRE have occurred from the late 1950s through the present as a result of operations at PRP facilities. These releases have been of sufficient quantity, concentration, and duration to potentially injure natural resources in the KRE. Natural resources potentially injured by the releases of hazardous substances include surface water (including sediments), soils, groundwater, fish, and wildlife. Based on these criteria, the Trustees have determined that there is a reasonable probability of making a successful natural resource damages claim.

Following publication of this preassessment screen and submission of a Notice of Intent to Perform an Assessment, the Trustees intend to prepare and publish an Assessment Plan for public comment. Following the public comment period, the Trustees will perform an assessment of natural resource damages. Following completion of the assessment, an Assessment Report will be prepared and published.

CHAPTER 1
INTRODUCTION

The hazardous substances polychlorinated biphenyls (PCBs) [Table 302.4 at 40 CFR § 302.4] have been released to the Kalamazoo River environment (KRE) by industrial activities in the vicinity of Kalamazoo, Michigan. As a result, on August 30, 1990, the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site was included on the National Priorities List (NPL) pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 U.S.C. §§ 9601 *et seq.*, as amended. On December 28, 1990, the State of Michigan entered into an Administrative Order by Consent (the Order) with Allied Paper, Inc. and its parent company, Millennium Holdings, Inc. (formerly HM Holdings); the Georgia-Pacific Corporation; and Plainwell Inc. (formerly the Simpson Plainwell Paper Company). Pursuant to the Order, these companies are undertaking a remedial investigation/feasibility study (RI/FS). In addition, the Fort James Corporation (formerly the James River Corporation) is participating in the RI/FS, although it is not a party to the Order.

The Director of the Michigan Department of Environmental Quality, the Attorney General of the State of Michigan, and the Regional Director of the U.S. Fish and Wildlife Service, in coordination with the Secretary of Commerce as represented by the National Oceanic and Atmospheric Administration (collectively, the Trustees), have begun to assess the natural resource damages in accordance with the NRDA regulations set forth at 43 CFR Part 11.[1] These regulations are not mandatory. However, assessments performed in compliance with these regulations have the force and effect of a rebuttable presumption in any administrative or judicial proceeding under CERCLA [42 U.S.C. § 9607(f)(2)(C)]. The first step in the process established by the U.S. DOI is the preparation of a preassessment screen.

This document contains the Preassessment Screen for the KRE natural resource damage assessment (NRDA). This screen documents the Trustees' conclusion, based on a "rapid review of readily available information that focuses on resources for which the Federal or State agency or Indian tribe may assert trusteeship," that there is a reasonable probability of making a successful claim for natural resource damages [43 CFR § 11.23(b)]. This screen was prepared by Stratus Consulting Inc. under DLZ Corporation's prime contract to the Michigan Department of Environmental Quality (DEQ).

1. 43 CFR Part 11 regulations were authored by the U.S. Department of the Interior (DOI), and are referred to as the U.S. DOI regulations in this document.

Following publication of this preassessment screen and submission of a Notice of Intent to Perform an Assessment, the Trustees intend to prepare a Natural Resource Damage Assessment Plan and publish the Assessment Plan for public comment. Following the public comment period, the Trustees will perform an NRDA. Following completion of the assessment, an Assessment Report will be prepared and published.

1.1 INTENT OF THE PREASSESSMENT SCREEN

The purpose of a preassessment screen is to determine whether a discharge or release of a hazardous substance warrants conducting an NRDA. It is intended to be based on "a rapid review of readily available information. . . [to] ensure that there is a reasonable probability of making a successful claim" [43 CFR § 11.23(b)].

1.2 CRITERIA TO BE ADDRESSED BY THE PREASSESSMENT SCREEN

The content and requirements of a preassessment screen are described in 43 CFR Part 11, Subpart B. Before proceeding past the screening phase, the Trustees evaluated whether all of the following criteria have been met [43 CFR § 11.23(e)]:

1. A release of a hazardous substance has occurred.

2. Natural resources for which the Trustees may assert trusteeship have been or are likely to have been adversely affected by the release.

3. The quantity and concentration of the released hazardous substance are sufficient to potentially cause injury to those natural resources.

4. Data sufficient to pursue an assessment are readily available or likely to be obtained at reasonable cost.

5. Response actions carried out or planned will not sufficiently remedy the injury to natural resources without further action.

It should be emphasized that a preassessment screen presents data sufficient to support the above criteria based on information readily available to the Trustees. It is *not* a summary of all existing data.

CHAPTER 2
INFORMATION ON THE SITE
[43 CFR § 11.24]

2.1 LOCATION AND DESCRIPTION OF THE ASSESSMENT AREA

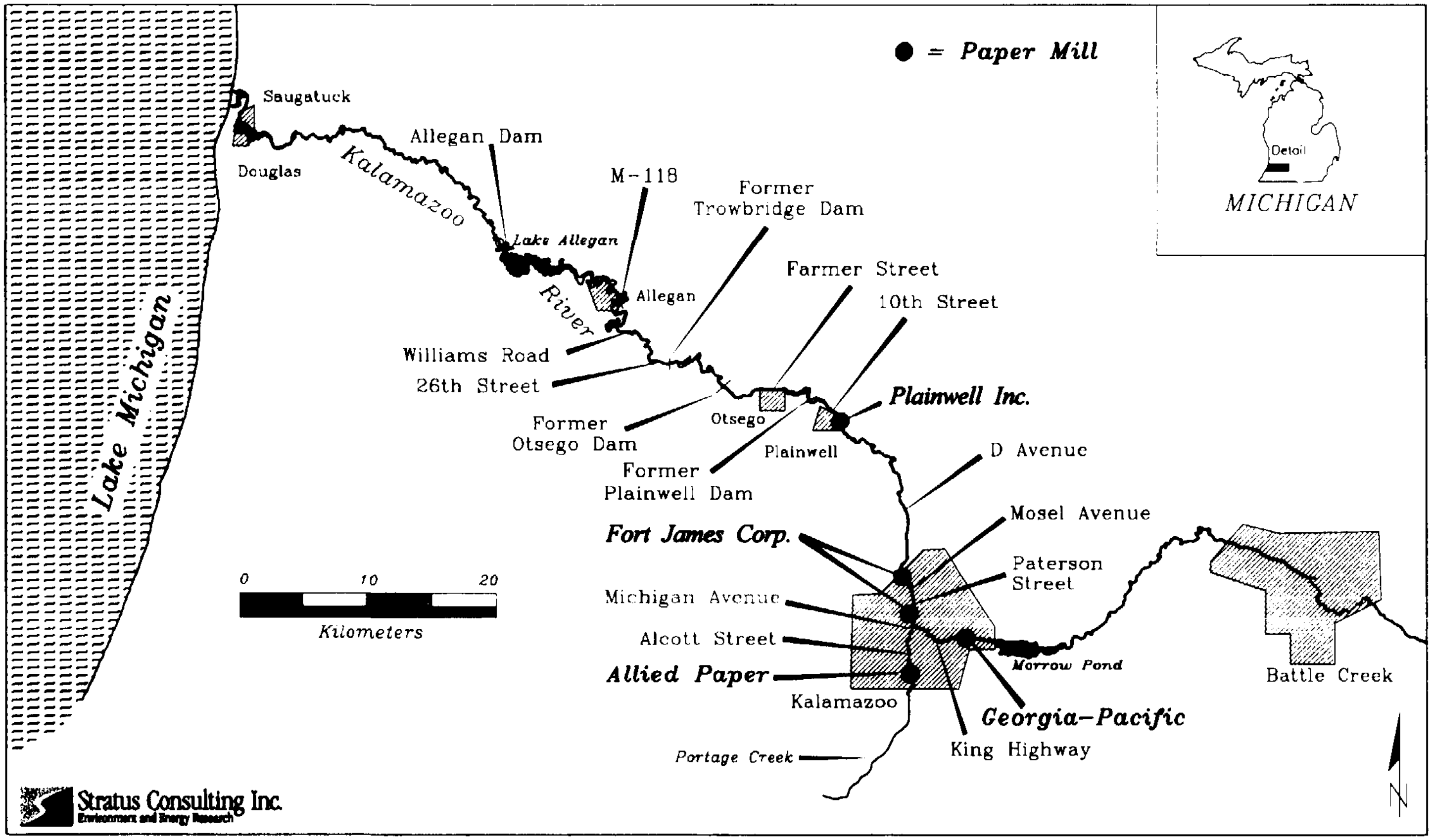
The Kalamazoo River drainage basin, located in southwestern Michigan, encompasses approximately 5,180 square kilometers (2,000 square miles) (Figure 2-1). The main stem of the Kalamazoo River is approximately 195 kilometers (120 miles) long and flows from the town of Albion, Michigan, to Lake Michigan near the city of Saugatuck, Michigan. Between Morrow Pond, just upstream of the city of Kalamazoo, and the river mouth, the river alternates between free-flowing sections and a series of dams. The Plainwell, Otsego, and Trowbridge dams have been lowered to their sill levels, exposing former impoundment sediments as floodplain soils (Blasland, Bouck & Lee, 1992). The river is still impounded by the Otsego City, Allegan City, and Lake Allegan (or Caulkins) dams (Blasland, Bouck & Lee, 1992). The lower Kalamazoo River, downstream of Lake Allegan, has been designated a Wild-Scenic River by the Michigan Natural Resources Commission under the Natural Rivers Act (Act 231 of the Public Acts of 1970) (Michigan DNR, 1987a).

The boundary (for listing purposes only) of the Allied Paper, Inc./Portage Creek/Kalamazoo River NPL Site includes Portage Creek from Cork Street just above the Bryant Mill Pond in the city of Kalamazoo, Michigan to its confluence with the Kalamazoo River, and the Kalamazoo River from this confluence downstream to the Allegan City Dam. In total, the area listed on the NPL includes a 5-kilometer (3-mile) stretch of Portage Creek and a 56-kilometer (35-mile) stretch of the Kalamazoo River (Figure 2-1).

However, the Michigan Department of Natural Resources (DNR) has expanded the RI due to the contamination extending downstream of the boundary noted in the NPL listing. The RI was expanded to address the Kalamazoo River from Morrow Pond Dam to the mouth of the Kalamazoo River at Lake Michigan [approximately 130 kilometers (80 miles)], as well as Portage Creek from Cork Street to its confluence with the Kalamazoo River [5 kilometers (3 miles)]. In addition, the section of the Kalamazoo River from the Morrow Pond Dam to Lake Michigan is an International Joint Commission Area of Concern.

PCB sources to the KRE include various industrial facilities in Kalamazoo and Plainwell (Figure 2-1). Allied Paper, Inc. facilities include the former Monarch and Bryant mills on Portage Creek in Kalamazoo and the King Mill on Lake Street in Kalamazoo. Georgia-Pacific

Figure 2-1
KRE Showing Industrial Facilities Operated by PRPs



The NPL site extends from just upstream of Allied Paper facilities on Portage Creek downstream to the Allegan City Dam. The NPL study area (and Michigan Act 307 site) includes the Kalamazoo River from Morrow Pond Dam to Lake Michigan and Portage Creek from just upstream of Allied Paper facilities to the creek mouth. The International Joint Commission Area of Concern extends from the Morrow Pond Dam on the Kalamazoo River to Lake Michigan.

Corporation facilities include several mills on the bank of the Kalamazoo River along King Highway in Kalamazoo. Plainwell Inc. facilities include a mill on the bank of the Kalamazoo River along Allegan Street in Plainwell. Fort James Corporation facilities include the Paperboard Packaging mill on Paterson Street in Kalamazoo, and the KVP Specialty Papers mill on Island Avenue in Parchment. Figure 2-1 shows the general locations of paper facilities in the Kalamazoo and Plainwell areas.

2.2 POTENTIALLY RESPONSIBLE PARTIES

For the NRDA, the Trustees have identified Allied Paper, Inc. and its parent company, Millennium Holdings, Inc. (Allied Paper); the Georgia-Pacific Corporation (Georgia-Pacific); Plainwell Inc. (Simpson Plainwell Paper); and the Fort James Corporation (Fort James) as potentially responsible parties (PRPs).[1] Other PRPs may be named at a later date as information becomes available.

2.3 HISTORY OF PCBS AT KALAMAZOO AREA PAPER MILLS

A major source of contamination by PCBs to river environments was the discharge of paper waste produced during the deinking and repulping of recycled carbonless copy paper material (Carr et al., 1977). When the recycled paper stream from Kalamazoo-area paper mills included carbonless copy paper containing PCBs (late 1950s to early 1970s), PCBs were present in the paper mill waste streams and were released into the KRE.

Carbonless copy paper manufactured between 1957 and 1971 contained Aroclor 1242 (A1242) as an ink carrier or solvent. The A1242 was used as a solvent for certain dyes that were encapsulated in small spheres and applied to one side of the paper during the coating process. The walls of the spheres would rupture and release the dye when subjected to pressure. The average A1242 content in a sheet of carbonless copy paper was 3.4% (Carr et al., 1977).

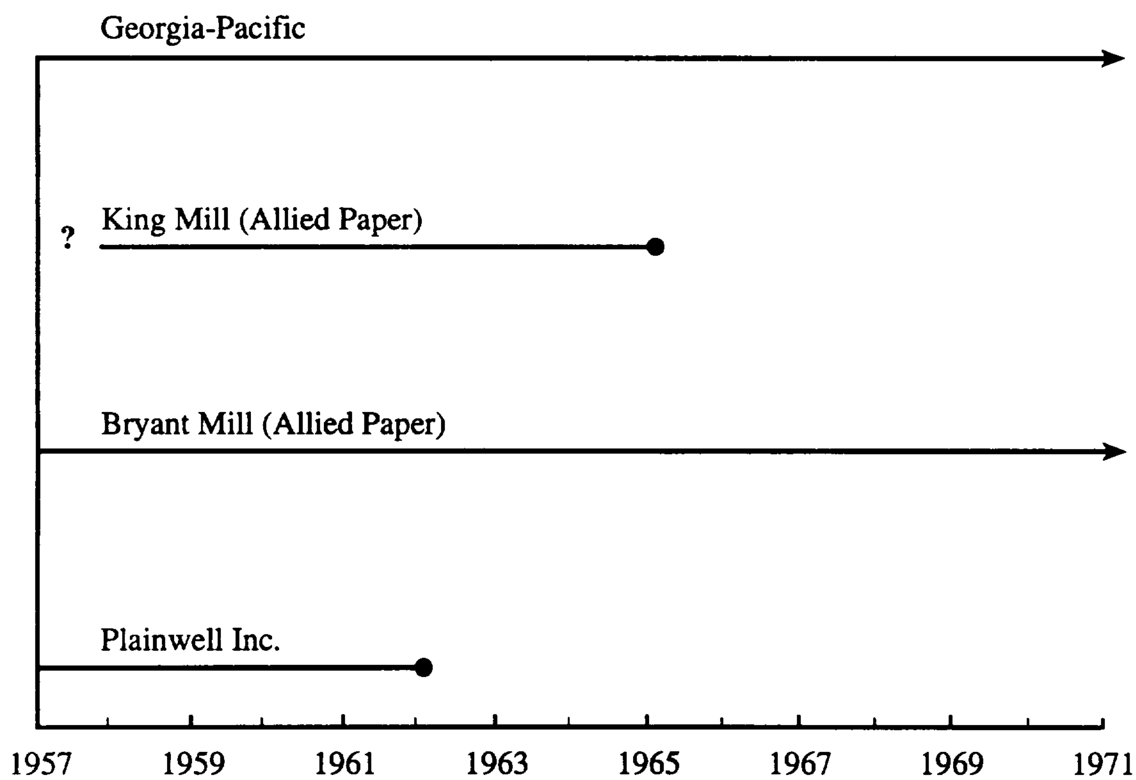
From 1957 to 1971, approximately 20,031,880 kilograms (44,162,000 pounds) of A1242 were used in the production of carbonless copy paper across the country. This amount accounted for an estimated 28% of all the PCBs that the Monsanto Chemical Company (the sole domestic producer of PCBs) sold for plasticizer applications during this period, and 6.3% of the Monsanto's total domestic sale of PCBs for those 15 years (Carr et al., 1977).

1. The term PRP as used in this document refers to parties potentially liable for natural resource damages under CERCLA and/or under Part 201 of the Michigan Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

The process of deinking and subsequent pulping of the recycled stock resulted in breakage of the spheres that contained the PCBs. These PCBs were then distributed throughout the paper recycling process, including in the waste stream, as described below. Some of the PCBs in the carbonless copy paper, however, remained in the recycled pulp and subsequently were incorporated into recycled paper products. For example, PCB concentrations as high as 433 mg/kg were measured in recycled paperboard used for cereal packaging in 1971, the year that PCB use in the manufacturing of carbonless copy paper was discontinued (Carr et al., 1977).

Allied Paper, Georgia-Pacific, and Plainwell Paper Inc. each deinked and repulped recycled carbonless copy paper stock for some period between 1957 and 1971 (the period when PCBs were used in the ink of carbonless copy paper). Figure 2-2 provides a time line showing when each company performed deinking operations within this period. In addition, the paper recycled by the Kalamazoo-area paper companies most likely continued to contain PCBs for several years after 1971.

Figure 2-2
Chronology of Deinking Operations at Four Kalamazoo Paper Mills during the Period when Carbonless Copy Paper Contained PCBs, 1957-1971



The starting date of deinking operations at the King Mill could not be determined. Arrowheads indicate that deinking of PCB-containing paper likely continued for some time after production of PCB-containing paper ceased.

Allied Paper deinked carbonless copy paper at two mills: the King Mill until 1965 (the starting date of deinking at this mill is not available), and the Bryant Mill for the entire 15-year period that PCBs were used in the manufacture of carbonless copy paper (1957-1971) (Blasland, Bouck & Lee, 1992). Georgia-Pacific deinked carbonless copy paper at two mills from 1957 to 1971. Mills 1 and 3 both started deinking in the early 1950s. Mill 3 discontinued deinking in the late 1960s, but Mill 1 continued deinking until the late 1970s (Blasland, Bouck & Lee, 1992). The Simpson Plainwell Paper mill deinked carbonless copy paper from 1957 until 1962. At the time, the mill was owned by the Hamilton Paper Company (Blasland, Bouck & Lee, 1992).

The process of deinking and repulping recycled paper produced a substantial quantity of paper waste. During the period of the mid-1950s to early 1970s, each of the PRP deinking mills had similar waste treatment systems. Raw paper waste, containing water, clay, and fibrous waste, was pumped to a primary clarifier that separated out much of the settleable solids. The waste from the clarifier included wastewater (effluent) and residual clay and fibrous solids (underflow, or residuals) (Blasland, Bouck & Lee, 1992).

Typically, the effluent from the clarifier was recycled through the process systems, discharged to Portage Creek or the Kalamazoo River, or discharged to a municipal wastewater treatment plant (WWTP). The clarifier residuals were pumped into dewatering lagoons and allowed to dry by evaporation for several months. The resulting dried residuals, consisting mostly of grey clay and wood fibers, were then removed from the dewatering lagoons and deposited in disposal areas or landfills along Portage Creek and the Kalamazoo River (Blasland, Bouck & Lee, 1992).

Table 2-1 lists PRP facilities where residuals were dewatered or disposed during the period when the waste stream most likely contained PCBs, and includes the maximum PCB concentration that has been measured at each facility. PCB concentrations up to 1,200 mg/kg have been measured in the material at the Bryant historical residual dewatering lagoon along Portage Creek (Blasland, Bouck & Lee, 1992; 1993a). For comparison, floodplain soil samples from the Kalamazoo River upstream of PRP facilities ranged from no detectable PCBs at detection limits ranging from 0.11 mg/kg to 0.39 mg/kg PCBs (Blasland, Bouck & Lee, 1994a). These data demonstrate that material in the waste stream from the PRP facilities contained highly elevated concentrations of PCBs.

2.4 TIME, QUANTITY, DURATION, AND FREQUENCY OF PCB RELEASES

PCBs were first used in carbonless copy paper in 1957 (Carr et al., 1977). PCB releases into the KRE from PRP facilities would have begun shortly thereafter, when the PCB-contaminated carbonless copy paper was recycled at the facilities. Since then, PCB releases from PRP facilities have been multiple and at times continuous. However, direct evidence of PCB releases from PRP facilities into the Kalamazoo River and Portage Creek is limited because effluent or residuals

Table 2-1
PRP Facilities where Recycled Paper Waste Stream Material was Dewatered or Disposed

Facility	Location	Approx. Area (hectares)	Maximum PCB Concentration (mg/kg)	Source
Monarch HRDLs[a]	Adjacent to Portage Creek	1	61	Blasland, Bouck & Lee, 1992; 1993b
Bryant HRDLs[a]	Adjacent to Portage Creek	5	1,200	Blasland, Bouck & Lee, 1992; 1993b
Bryant Mill Pond	Adjacent to Portage Creek	9	1,000	Blasland, Bouck & Lee, 1992
A-Site Landfill	Adjacent to the Kalamazoo River in the City of Kalamazoo	9	148	Blasland, Bouck & Lee, 1992; Swanson Environmental, 1990
Willow Boulevard Landfill	Adjacent to the Kalamazoo River in the City of Kalamazoo	4	167	Swanson Environmental, 1987
King Highway Landfill	Adjacent to the Kalamazoo River in the City of Kalamazoo	9	77	Blasland, Bouck & Lee, 1992; 1993a; 1994c
12th Street Landfill	Adjacent to the Kalamazoo River in Plainwell	3	120	Blasland, Bouck & Lee, 1992; Geraghty & Miller, 1994
KVP Type II Landfill	Adjacent to the Kalamazoo River in Parchment	6	30	STS Consultants, 1989; Williams, 1979
KVP Type III Landfill	Adjacent to the Kalamazoo River in Parchment	10	(no data available)	STS Consultants, 1989

a. HRDLs = historical residuals dewatering lagoons.

were not analyzed for PCBs until after the use of PCBs in carbonless copy paper was discontinued in 1971.

There is evidence that Allied Paper discharged raw paper waste to surface water during the period when the facilities were deinking PCB-contaminated paper. Despite the presence of the primary clarifiers, direct discharges of raw paper waste into Portage Creek and the Kalamazoo River still occurred. For example, on several site inspections, the Michigan Water Resources Commission noted that the waste treatment systems at the Bryant Mill and King Mill were inoperational or being bypassed (Michigan Water Resources Commission, 1961; 1964a; 1964b; 1967). Allied Paper claims to have released 70,760 kilograms (156,000 pounds) of paper waste per day to Portage Creek and the Kalamazoo River in 1961, 3,000 kilograms (6,600 pounds) per day by 1968, and 600 kilograms (1,250 pounds) per day by 1970 (Allied Paper, Inc., 1970). Based on the fact that dewatered residuals produced during this same time period contained elevated concentrations of PCBs (see Table 2-1), it is likely that the raw paper waste discharged from PRP facilities directly into Portage Creek and the Kalamazoo River also contained elevated PCB concentrations.

Other evidence of PCB releases into the KRE include elevated PCB concentrations in effluent discharged from PRP facilities, in sediments of drainage ditches that lead from PRP facilities to Portage Creek and the Kalamazoo River, and in surface runoff from PRP facilities. Effluent from both Plainwell Inc. mill (up to 0.13 μg/L PCB) and the Fort James KVP mill has released PCBs directly to the Kalamazoo River (Michigan Water Resources Commission, 1972b; 1973a; 1975; Michigan DNR, 1978; 1987b; Blasland, Bouck & Lee, 1992). PCBs have been measured at concentrations up to 37 mg/kg in a former channel that discharged effluent and/or raw paper waste directly into Portage Creek from Allied Paper facilities (Michigan DNR, 1990a), and up to 64 mg/kg in the King Street storm sewer, which discharges to the Kalamazoo River from Allied Paper's King Mill and/or Georgia-Pacific's King Highway Landfill (Michigan DNR, 1976a; Blasland, Bouck & Lee, 1992). Surface runoff from residuals dewatering and storage areas has also been documented to release PCBs to Portage Creek at concentrations up to 56.0 μg/L. (Michigan Water Resources Commission, 1973b; Blasland, Bouck & Lee, 1992).

PCB releases from PRP facilities into groundwater have also been documented (Michigan Water Resources Commission, 1973b; Michigan DNR, 1976b; Blasland, Bouck & Lee, 1992). Georgia-Pacific has released PCBs directly into groundwater from some of its disposal area facilities (Georgia-Pacific, 1988; Dell Engineering, 1988; Blasland, Bouck & Lee, 1992). PCBs have been measured at elevated concentrations in groundwater seeps or leachate at PRP dewatering lagoons (Michigan DNR, 1976b; Blasland, Bouck & Lee, 1992).

The re-release of PCBs through erosion, resuspension, groundwater movement, and downstream transport is an ongoing process. Several landfills, disposal areas, and historical residual dewatering lagoons (HRDLs) that contain PCB-contaminated residuals are located immediately adjacent to the Kalamazoo River. Along Portage Creek, the Bryant and Monarch HRDLs and the former Bryant Mill Pond are located immediately adjacent to the creek. At all of these sites, creek erosion of PCB-contaminated waste can release PCBs directly into the Kalamazoo River or Portage Creek, particularly during periods of high flow. For example, it has been estimated that 90% of the PCB releases into Portage Creek in 1988 were from erosion of PCB-contaminated materials that came from the former Bryant Mill Pond (Peterson, 1988).

Erosion of PCB-contaminated waste can also occur from downstream areas of the Kalamazoo River and Portage Creek, where waste carried downstream has accumulated in floodplains or former impoundments. The Michigan DNR (1983) estimated that the submerged sediments and floodplain soils of Portage Creek and the Kalamazoo River depositional areas (former Bryant Mill Pond, Lake Allegan, and Plainwell, Otsego, and Trowbridge former impoundments) contain almost 103,400 kilograms (228,000 pounds) of PCBs. At the former dam impoundment areas, the Kalamazoo River currently cuts through floodplains that were deposited as bottom sediments behind the dams when the dams were in operation. These floodplains contain elevated PCB concentrations, and the ongoing erosion of them by the river can re-release PCBs into the river.

2.5 RELEVANT OPERATIONS OCCURRING AT OR NEAR THE SITE

Operations relevant to PCB releases into the KRE include paper-making operations at most of the PRP paper mills. With the exception of the King, Bryant, and Monarch mills in Kalamazoo, all of the PRP paper mills described in the above sections continue to operate. (The Bryant and Monarch mills have been replaced by the Portage Mill on an adjacent piece of property.) In 1988, Allied Paper sold the Portage Mill to Performance Paper (Blasland, Bouck & Lee, 1992).

CERCLA RI/FS actions are ongoing in the KRE. The primary goals of the RI/FS are to gather sufficient information to characterize the nature and extent of risks to human health and the environment, to evaluate potential remedial options, and to support an informed management decision (U.S. EPA, 1988). An Administrative Order by Consent that outlines the RI and sets a course for cleanup feasibility studies in the basin became effective on December 28, 1990 (Blasland, Bouck & Lee, 1993a).

Draft work plans for the RI/FS studies were submitted to the Michigan DNR in March 1991. The proposed scope of study included the Kalamazoo River, Portage Creek, former Bryant Mill Pond area, and the Allied Paper, Inc. paper residuals dewatering lagoons and residuals disposal areas. This list was expanded on January 31, 1992, to include operable units (OUs) that may be sources of PCBs to the Kalamazoo River and Portage Creek. The site was segmented into five areas to allow RI/FS activities to proceed on different schedules:

- King Highway Landfill OU
- Willow Boulevard and A-Site OU
- 12th Street Landfill OU
- Allied Paper OU, including the Bryant and Monarch HRDLs and the former Bryant Mill Pond impoundment area
- Kalamazoo River from the Morrow Pond Dam to Lake Michigan, which includes Portage Creek from Alcott Street to the Kalamazoo River.

The Michigan DNR outlined procedures for the PRPs to follow at each OU. The procedures include conducting the RI by incorporating historical data with new confirmatory data for all media to be addressed, developing the FS by working closely with the State of Michigan and the U.S. Environmental Protection Agency (U.S. EPA) to evaluate three to five remedial alternatives, developing a proposed plan, and developing a source control OU Record of Decision (ROD) to explain how the material in each OU will be remediated (Blasland, Bouck & Lee, 1993a).

A ROD for the King Highway Landfill OU was signed by the MDEQ on October 17, 1997 and the U.S. EPA on February 10, 1998, followed by an Administrative Order by Consent between the State of Michigan and Georgia-Pacific in February of 2000. The response activities defined in the ROD and Statement of Work addressed the removal of PCB-contaminated paper residuals, soils, and sediments from various sites in and around the OU, followed by consolidation of the excavated material into the King Highway Landfill, which would be capped, fenced, and deed restricted. The areas defined for the removal activity were: a portion of the Kalamazoo River adjacent to the King Highway Landfill; the King Street Storm Sewer and portions of the floodplain adjacent to the storm sewer; five former Mill Lagoons, and a floodplain between the Mill Lagoons and the Kalamazoo River in the area of Georgia-Pacific's mill. On-site construction activities called for in the ROD and SOW are nearing completion.

There have been interim response activities ongoing in 1999-2000 at the Willow Boulevard/A-Site OU, including placement of sheet piling along the river side of the A-site portion of the OU and limited removal of PCB-containing sediments in low energy areas of the Kalamazoo River near the disposal areas. These limited removal actions are not considered to be final remedial actions as some PCB concentrations in the areas addressed still do not meet the applicable criteria for sediment of 0.12 mg/kg established by the Kalamazoo River ecological risk assessment. The RI report for this OU has been submitted to the Michigan DEQ but not finalized.

There has been an RI, FS, and Proposed Plan for the 12th Street Landfill OU, and a ROD for the OU is expected to be finalized in spring of 2000.

The U.S. EPA and their contractors conducted a time-critical removal cleanup action at the Bryant Mill Pond, a portion of the Allied Paper, Inc. OU, beginning in October, 1998. The work was funded by Millennium Holdings, Inc., through an administrative order between Millennium Holdings, Inc. and the U.S. EPA, CERCLA Docket No. V-W-98-C-473, dated June 2, 1998. The cleanup action included removal of PCB-contaminated paper residuals from the creek bed and former impoundment area, and placement of the excavated material on-site in the Historic Residual Dewatering lagoon and the Former Residuals Dewatering lagoons. Further interim response actions to stabilize the waste that was relocated during the removal action are still in progress at the OU.

The RI Report for the Kalamazoo River from Morrow Dam to the Lake Allegan Dam (Calkins Dam) is expected in September of 2000. An additional RI for the lower reach of the river, from Calkins Dam to Lake Michigan, is expected after additional investigation work in the area, including sampling of sediment and floodplain soil, has been completed.

As part of the RI/FS process, an ecological risk assessment was produced for the Michigan DEQ by Camp, Dresser, and McKee. The focus of the report was on the potential ecological effects of elevated PCB concentrations in surface water, sediment, surface soil, and biota. The species identified as potential receptors, defined as inhabiting or using the aquatic, riparian/wetland and terrestrial habitats of the site, can be broken down into nine groups of organisms: aquatic plants, aquatic macroinvertebrates, freshwater game fish, freshwater forage fish, freshwater rough fish, terrestrial invertebrates, small burrowing terrestrial and semi-aquatic mammals, small carnivorous or omnivorous mammals, and top predators (CDM, 1999).

The ecological risk assessment is based on site-specific data on PCB concentrations in surface water, sediment, soil, fish tissue, small mammal tissue, and bird eggs. These data are compared to toxicity thresholds to evaluate PCB risk as hazard quotients, calculated by dividing an exposure concentration by an effect threshold concentration. The risk assessment also incorporated dietary information into a food chain model to predict dietary intake of PCBs by fish-eating birds and mammals and other predators (CDM, 1999).

The ecological risk assessment made the following conclusions (CDM, 1999):

- based on hazard quotients, mink are at the most risk from exposure to PCBs compared to other receptor species

- most aquatic biota are unlikely to be adversely affected through exposure to the surface water

- elevated PCB concentrations in surface water and streambed sediments are likely to affect sensitive piscivorous species (for example, mink) through ingestion of PCB-contaminated prey, and may also effect less sensitive piscivorous predators (for example, bald eagles)

- depending on life histories and sensitivities to PCBs, some terrestrial and semi-aquatic biota might be at generally low to moderate risk from elevated PCB concentrations in floodplain sediment and surface soil

- unless they reside in the most contaminated areas or have a diet consisting of prey either residing in PCB-contaminated areas or having substantial amount of PCB uptake, omnivorous (for example, mice) and carnivorous (for example, the red fox) terrestrial species are unlikely to be at significant risk

- omnivorous birds (for example, the robin) whose diet include a substantial amount of vegetation would be at significant risk if the plant PCB uptake rate approached the predicted rate used in the ecological risk assessment; the uptake rate is assumed to be an over-estimate to some extent, and consumption of terrestrial invertebrates (for example, earthworms) is expected to be a larger contributor to PCB intake

- omnivorous birds with diets high in contaminated invertebrates would be at higher risk than omnivorous birds with diets high in vegetation

- assuming that muskrats (a representative semi-aquatic herbivorous mammal) and rats are equally sensitive to PCBs via ingestion, semi-aquatic herbivorous mammals may be at risk.

An ecological risk assessment addendum that evaluates additional data, including data on PCB uptake in plants and PCB concentrations in bird eggs collected at the site, is being prepared (personal communication, Ron French, CDM, 2000). However, the addendum was not available at the time of the preparation of the Preassessment Screen.

2.6 DAMAGES EXCLUDED FROM LIABILITY

The Trustees are not aware of any natural resource damages that would be excluded from liability under CERCLA or under Part 201, Environmental Remediation, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, Michigan Combined Laws (MCL) 324.20101 et seq. Based on the available information, none of the conditions for exclusion from CERCLA or Part 201 liability apply [43 CFR § 11.24(b); M.C.L. 324.20126a(5)]. Specifically:

i. The damages resulting from the releases have not been specifically identified as an irreversible and irretrievable commitment of natural resources in an environmental impact statement or other comparable environmental analysis, no decisions were undertaken by the State to grant permits or licenses authorizing such commitments of natural resources, and PRP facilities were not otherwise operating within the terms of such permits or licenses.

ii. Damages and the releases of hazardous substances from which such damages resulted have not occurred wholly before enactment of CERCLA.

iii. Damages have not resulted from the application of a pesticide product registered under the Federal Insecticide, Fungicide, and Rodenticide Act, 7 U.S.C. §§ 135-135k.

iv. Damages have not resulted from any other federally permitted release, as defined in §§ 101(10) of CERCLA, or from a State permitted release, as defined in §20101(1)(aa) of Part 201, Environmental Remediation, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

CHAPTER 3
PRELIMINARY IDENTIFICATION OF RESOURCES AT RISK [43 CFR § 11.25]

3.1 PRELIMINARY PATHWAY IDENTIFICATION [43 CFR § 11.25(a)]

Actual or potential sources of PCB releases include approximately 60 hectares (140 acres) of PCB-contaminated landfills and HRDLs in the Kalamazoo/Plainwell area (STS Consultants, 1989; Blasland, Bouck & Lee, 1992; Geraghty & Miller, 1994), and PCB-contaminated sediments and floodplain soils behind impoundments on the Kalamazoo River with an estimated surface area of 1,250 hectares (3,100 acres) (Johnson et al., 1988). These sediments in depositional areas contain an estimated 103,400 kilograms (228,000 pounds) of PCBs (Michigan DNR, 1983). Exposure pathways that may transport hazardous substances released from sources to other natural resources include the following:

a. ***Surface water/sediment pathway.*** The lower five kilometers (three miles) of Portage Creek and the Kalamazoo River from Morrow Pond Dam to Lake Michigan contain elevated concentrations of PCBs as a result of releases from PRP facilities (Michigan DNR, 1987a; Marti and Armstrong, 1990; Blasland, Bouck & Lee, 1994b). Surface runoff and surface water in lower Portage Creek and the Kalamazoo River flows over and through the PCB depositional areas behind dams, eroding contaminated floodplain soils and re-suspending contaminated sediments, and thus exposing surface water to PCBs in sediments and soils. Exposed surface water then transports and redistributes PCBs to surface water resources farther downstream. The estimated PCB load from the Kalamazoo River to Lake Michigan is 47 to 199 kilograms per year (104 to 439 pounds per year) (Horvath, 1984). Aquatic and terrestrial biota are exposed to PCBs via the surface water sediment pathway by ingestion and dermal/opercular absorption.

b. ***Groundwater pathway.*** Groundwater contaminated by direct contact with PCBs in soils or by contact with landfill material or PCB-contaminated floodplain soils is released to surface water via springs and seeps (Michigan DNR, 1987c; Dell Engineering, 1988; Blasland, Bouck & Lee, 1992). Contaminated groundwater along Portage Creek and the Kalamazoo River also likely discharges directly to the creek or river.

c. ***Soil pathway.*** The assessment area includes approximately 9 hectares (22 acres) of PCB-contaminated floodplain soils along Portage Creek and an estimated 200 hectares (507 acres) of contaminated floodplain soils along the Kalamazoo River (Blasland, Bouck & Lee, 1992). PCBs were transported to floodplain depositional areas primarily by surface water; the contaminated floodplain soils are former sediments that were exposed to the surface by receding water levels when dams were decommissioned and partially removed (Blasland, Bouck & Lee, 1992). Soils overlying contaminated paper waste in landfills are in direct contact with PCBs and thus are exposed to the hazardous substance. Soils serve as a pathway of contamination to surface water resources of Portage Creek and the Kalamazoo River through erosion and entrainment during high water, snowmelt, and precipitation-induced runoff. Groundwater can also be exposed to PCBs in the soil by leaching. Terrestrial biota resources may be exposed to PCBs in soil by dermal contact, uptake, and ingestion of the exposed floodplain soils, waste disposal areas, and other contaminated soils within the KRE.

d. ***Air pathway.*** Air may serve as an exposure pathway to soils, surface water, and terrestrial biota by transport of particulate and volatile emissions of PCBs from the OUs. Volatile PCB emissions have been detected in the ambient air at Allied Paper OU and Willow Boulevard/A-Site OU at concentrations exceeding local background concentrations (Blasland, Bouck & Lee, 1994c; 1994e). Terrestrial biological resources may be exposed to PCBs by inhalation of PCBs in air.

e. ***Food chain pathway.*** Food chain exposures occur when PCBs accumulate in the tissues of prey organisms and predators consume the prey. PCBs readily bioaccumulate in biota, thus making the food chain pathway an important exposure pathway for predators (Eisler, 1986; Ram and Gillett, 1993).

Lower trophic level organisms such as plankton, algae, vegetation, and invertebrates are exposed to PCBs directly from sediments, surface water, paper waste, soils, or air. Accumulated or adhering PCBs are then transferred to middle-level consumers, which may include amphibians, reptiles, bottom-dwelling fish, and insectivorous birds and mammals. Higher order consumers such as pelagic fish, raptors, and carnivorous mammals may then be exposed to PCBs in their prey.

Some example food chain pathways in the KRE include:

- PCB uptake by plankton and aquatic invertebrates that serve as prey for fish [e.g., carp (*Cyprinus carpio*), channel catfish (*Ictalurus punctatus*), smallmouth bass (*Micropterus dolomieui*), walleye (*Stizostedion vitreum*), rainbow trout (*Oncorhynchus mykiss*)], which in turn are consumed by other fish, piscivorous birds [e.g., great blue heron (*Ardea herodias*), bald eagle (*Haliaeetus leucocephalus*)], and mammals [e.g., river otter (*Lutra canadensis*), mink (*Mustela vison*)].

- PCB uptake by terrestrial invertebrates (e.g., earthworms, grasshoppers) that serve as prey for insectivorous birds [e.g., American robin (*Turdus migratorius*), American woodcock (*Scolopax minor*)], reptiles [e.g., eastern garter snake

(*Thamnophis sirtalis*)], amphibians [e.g., common gray treefrog (*Hyla versicolor*)], and small mammals [e.g., white-footed mouse (*Peromyscus leucopus*)], which in turn are consumed by raptors [e.g., red-tailed hawks (*Buteo jamaicensis*), great horned owls (*Bubo virginianus*)] and carnivorous mammals [e.g., red fox (*Vulpes vulpes*)].

3.2 EXPOSED AREAS [43 CFR § 11.25(b)]

This section presents preliminary estimates of exposed areas based on a review of readily available information. This section is *not* a comprehensive quantification of all exposed areas.

3.2.1 Primary Exposure Areas

The primary areas exposed to PCBs released from PRP facilities include landfills and HRDLs containing contaminated paper residuals; Portage Creek and Kalamazoo River surface water, sediments and floodplain soils downstream of PRP facilities; and Lake Michigan surface water and sediments. These areas include, but are not limited to, the following:

a. approximately 60 hectares (140 acres) of landfills and HRDLs containing PCB-contaminated paper residuals, including the Monarch and Bryant HRDLs and the A-Site, Willow Boulevard, King Highway, 12th Street, and Fort James KVP landfills (Michigan DNR, 1987b; Blasland, Bouck & Lee, 1992)

b. approximately 200 hectares (530 acres) of exposed PCB-contaminated floodplain soils behind former impoundments in the KRE (Blasland, Bouck & Lee, 1992)

c. Portage Creek surface water, sediments, and aquatic biota from Cork Street in Kalamazoo to the confluence with the Kalamazoo River, a distance of approximately 5 kilometers (3 miles) (Blasland, Bouck & Lee, 1992)

d. Kalamazoo River surface water and aquatic biota from the Morrow Pond Dam to the mouth of the river at Lake Michigan, a distance of approximately 130 kilometers (80 miles) (Blasland, Bouck & Lee, 1992; Marti and Armstrong, 1990; Horvath, 1984)

e. Kalamazoo River sediments from the Morrow Pond Dam at least as far downstream as the Lake Allegan Dam (Michigan DNR, 1987a; GZA/Donahue, 1990; Blasland, Bouck & Lee, 1992, 1994f, 1994g)

f. groundwater beneath the Allied Paper facilities along Portage Creek

g. an undetermined area of surface water, sediments, and aquatic biota in Lake Michigan.

3.2.2 Areas of Indirect Effect

Areas of indirect effect, where PCBs may have been redistributed from the KRE via air and biologic pathways, include:

a. other areas that bird and fish species visit after being exposed to PCBs in the KRE, including areas immediately surrounding the KRE that may be visited by resident birds, areas in and around Lake Michigan that may be visited by migratory fish, and areas that may be visited by migratory birds

b. areas indirectly exposed to KRE PCBs via aerial transport of PCBs.

3.3 ESTIMATES OF CONCENTRATIONS [43 CFR § 11.25(d)]

This section presents examples of concentrations of PCBs that have been measured in natural resources of the KRE. Many studies of contamination of the area have been conducted in the last 28 years; the information presented here is not intended to be a comprehensive review of these studies.

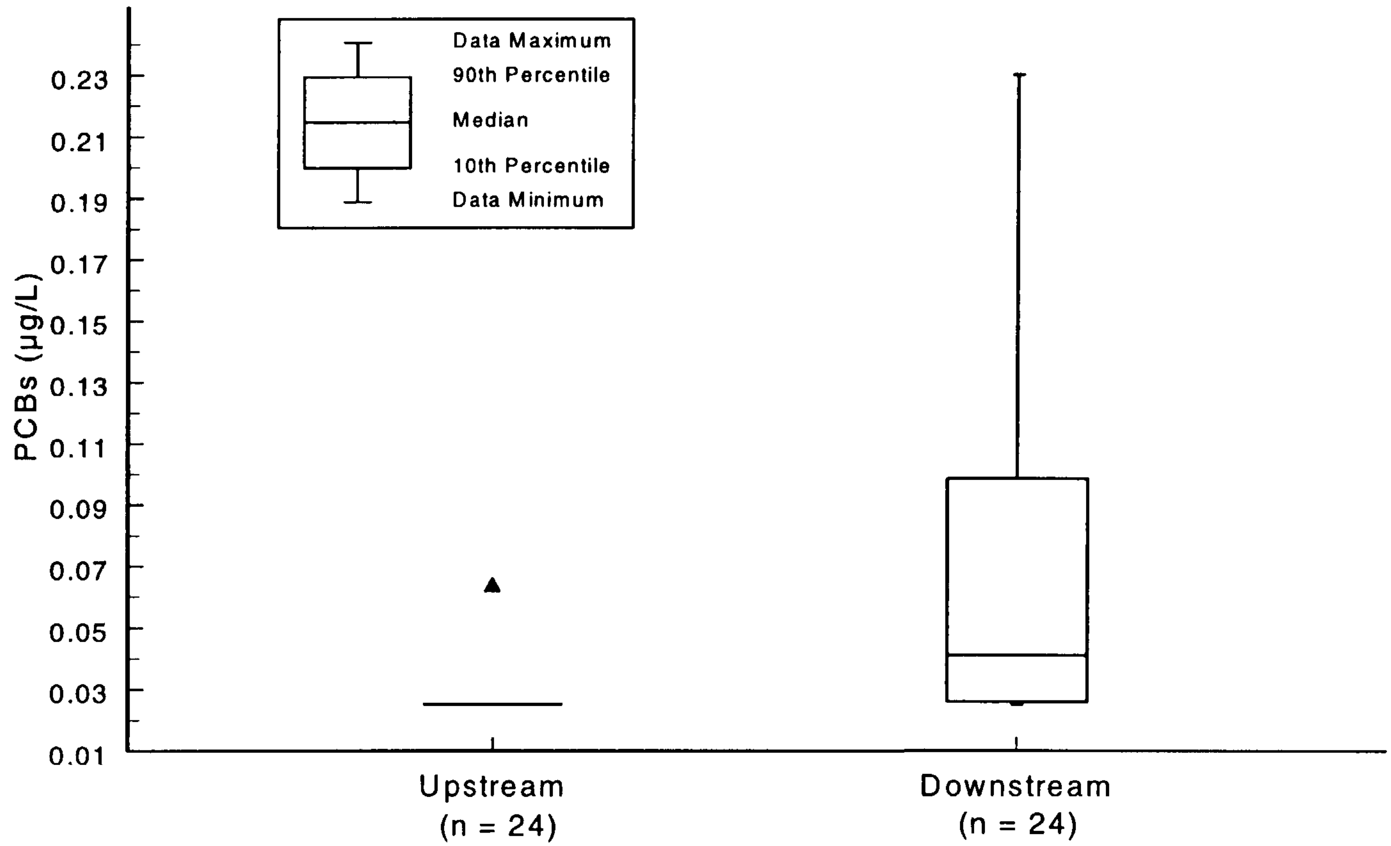
3.3.1 Surface Water/Sediments

Surface Water

Studies have shown that PCB concentrations in Portage Creek surface water increase substantially downstream of the Allied Paper facilities. For example, in 1993, Blasland, Bouck & Lee (1994b) collected water samples during high- and low-flow conditions in Portage Creek. Twenty-four samples were collected upstream of Allied Paper at Cork Street, and 24 samples were collected downstream of Allied Paper at Alcott Street. Concentrations measured in surface water samples collected in Portage Creek downstream of Allied Paper facilities greatly exceeded those measured upstream of facilities (Figure 3-1). Upstream of the facilities, PCBs were detected in only 1 of the 24 samples analyzed; downstream, PCBs were detected in 21 of the 24 samples analyzed and measured as high as 0.23 µg/L. In 1994, PCBs were detected in all 30 samples analyzed, including concentrations as high as 0.22 µg/L (Blasland, Bouck & Lee, 1995).

Furthermore, between 1985 and 1987, Michigan DNR collected 27 samples in Portage Creek downstream of Allied Paper at Alcott Street, and 25 samples upstream of Allied Paper. PCBs were detected above the study's reported 0.01 µg/L detection limit in all 27 downstream samples (Michigan DNR, 1987a; Figure 3-2). In contrast, upstream of Allied Paper facilities, only one of the 25 samples collected contained PCBs in detectable concentration (0.02 µg/L).

Figure 3-1
Surface Water PCB Concentrations Measured in Portage Creek in 1993 Upstream (at Cork Street) and Downstream (at Alcott Street) of Allied Paper Facilities



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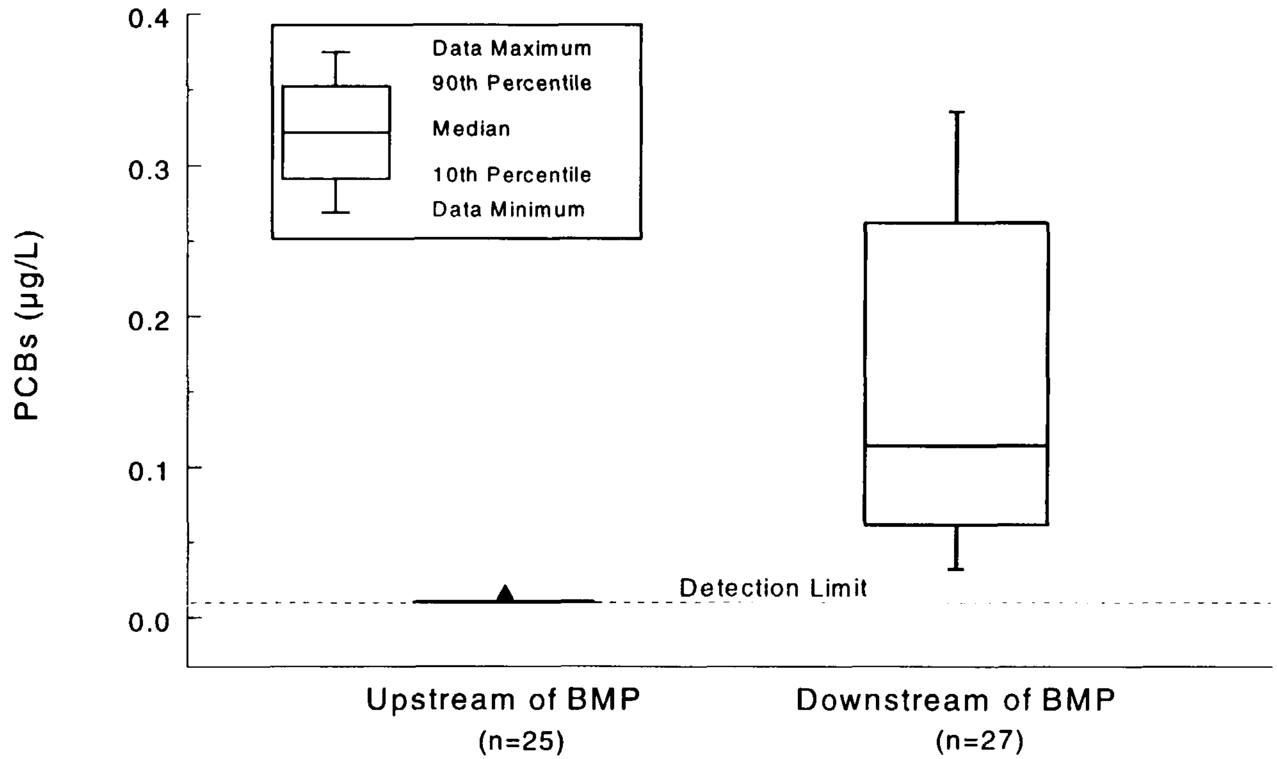
At the upstream site, PCBs were detected in a single sample, represented by the individual data point. The minimum values were not detected at a detection limit of 0.05 µg/L and are represented by one half the detection limit.

Figure 3-2
PCB Concentrations in Portage Creek Surface Water Upstream (at Cork Street) and Downstream (at Alcott Street) of Allied Paper Facilities, 1985-1987



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BMP = former Bryant Mill Pond.

The Michigan DNR collected data on PCB concentrations in Kalamazoo River surface water between 1985 and 1987 (Michigan DNR, 1987a). Ninety-eight surface water samples were collected at locations throughout the Kalamazoo River and analyzed for PCBs. Sample locations are shown in Figure 3-3.

At River Street, upstream of PRP paper facilities, PCB concentrations in the Kalamazoo River were undetected at a detection limit of 0.010 µg/L in 53% of the samples collected. Detected PCB concentrations were less than 0.030 µg/L (mean 0.018 µg/L for eight samples), except for one sample with a reported concentration of 0.138 µg/L. Downstream of PRP facilities, PCB concentrations generally exceeded those measured upstream (Figure 3-4). PCBs were detected in all the samples collected between 10th Street and M-118 and in more than 50% of the samples collected between King Highway and D Avenue. Mean PCB concentrations increase by almost 30% between D Avenue and 10th Street in Plainwell and remain elevated throughout the rest of the Kalamazoo River to Lake Allegan. PCB concentrations measured in the Kalamazoo River downstream of D Avenue range from 0.012 µg/L at 10th Street to 0.193 µg/L at M-118 (Figure 3-4).

In 1994, Blasland, Bouck & Lee (1995) collected 143 samples in the Kalamazoo River and 30 samples in Portage Creek, although a relatively high detection limit (0.025 µg/L) makes it difficult to compare data to previous studies. Nevertheless, PCBs were detected in 37 samples in the Kalamazoo River and in all 30 samples collected in Portage Creek. Concentrations were as high as 0.22 µg/L, with the highest concentrations in Portage Creek.

Sediments

Bed, bank, and shoreline sediments are considered to be a component of surface water resources [43 CFR § 11.14 (pp)]. Several studies have shown a substantial increase in PCB concentrations in Portage Creek sediment downstream of the Allied Paper facilities. These studies include Michigan Water Resources Commission (1973b), Michigan DNR (1983, 1984, 1987a), Limno-Tech (1987), GZA/Donahue (1990), and Blasland, Bouck & Lee (1992, 1994f). The results of these studies, which were conducted prior to the time-critical removal action undertaken in 1998, are summarized in Figure 3-5. Portage Creek surficial sediment PCB concentrations at and downstream of the former Bryant Mill Pond are one to two orders of magnitude greater than concentrations upstream (Figure 3-5). PCB concentrations in surficial bed sediments at the former Bryant Mill Pond have been measured as high as 369 mg/kg (Michigan Water Resources Commission, 1973b). Downstream of the former pond, PCB concentrations as high as 118 mg/kg have been measured in Portage Creek sediments (Michigan DNR, 1987a). Sampling conducted after the sediment removal in 1998 shows sediment PCB concentrations ranging from nondetect to 0.46 ppm (Michigan DEQ, 1999a).

Between 1976 and 1993, several studies measured PCB concentrations in Kalamazoo River sediments. These studies include Michigan DNR (1983, 1986, 1987a, 1990b, 1991),

Figure 3-3
Locations of Surface Water Samples Collected from the Kalamazoo River, 1985-1987

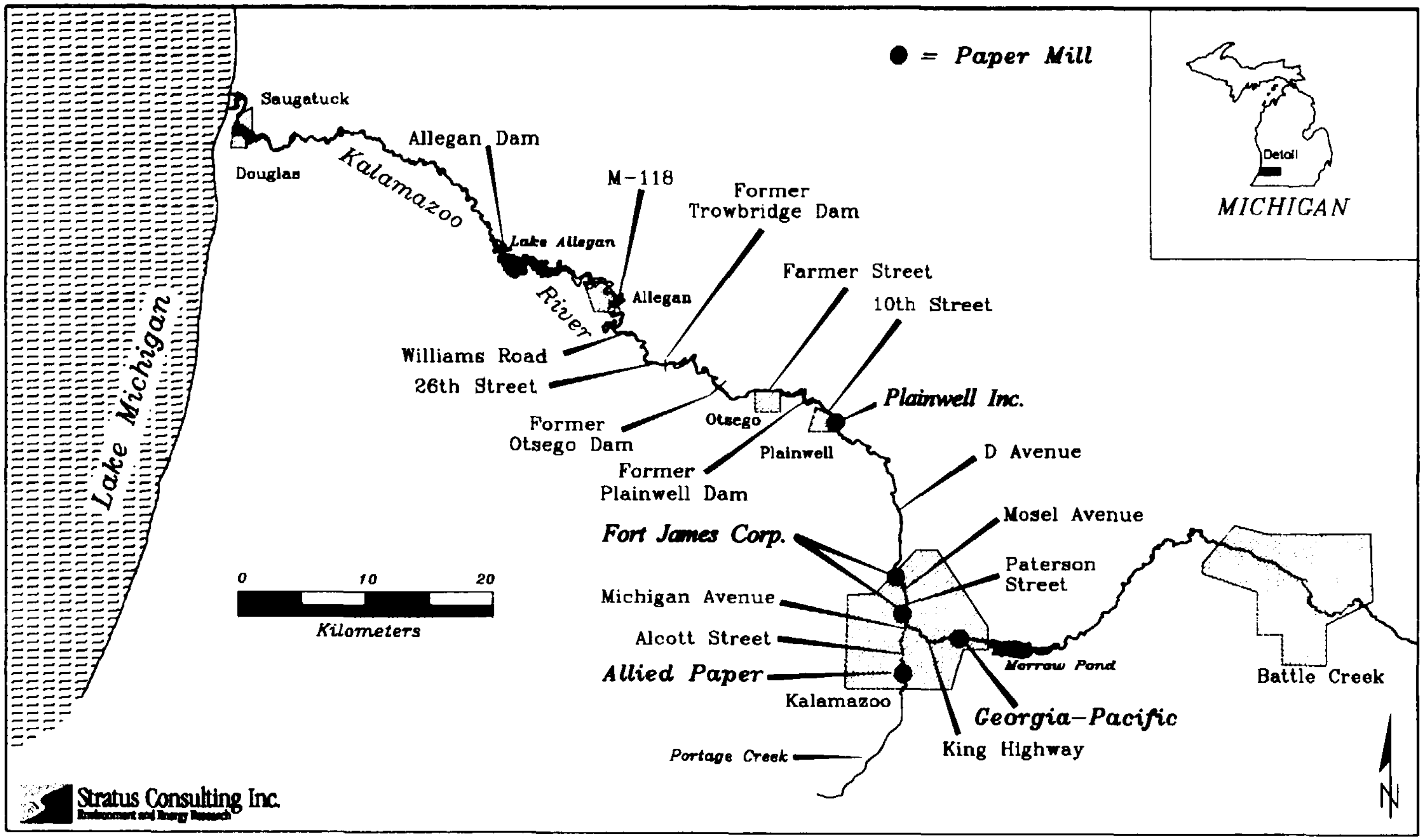
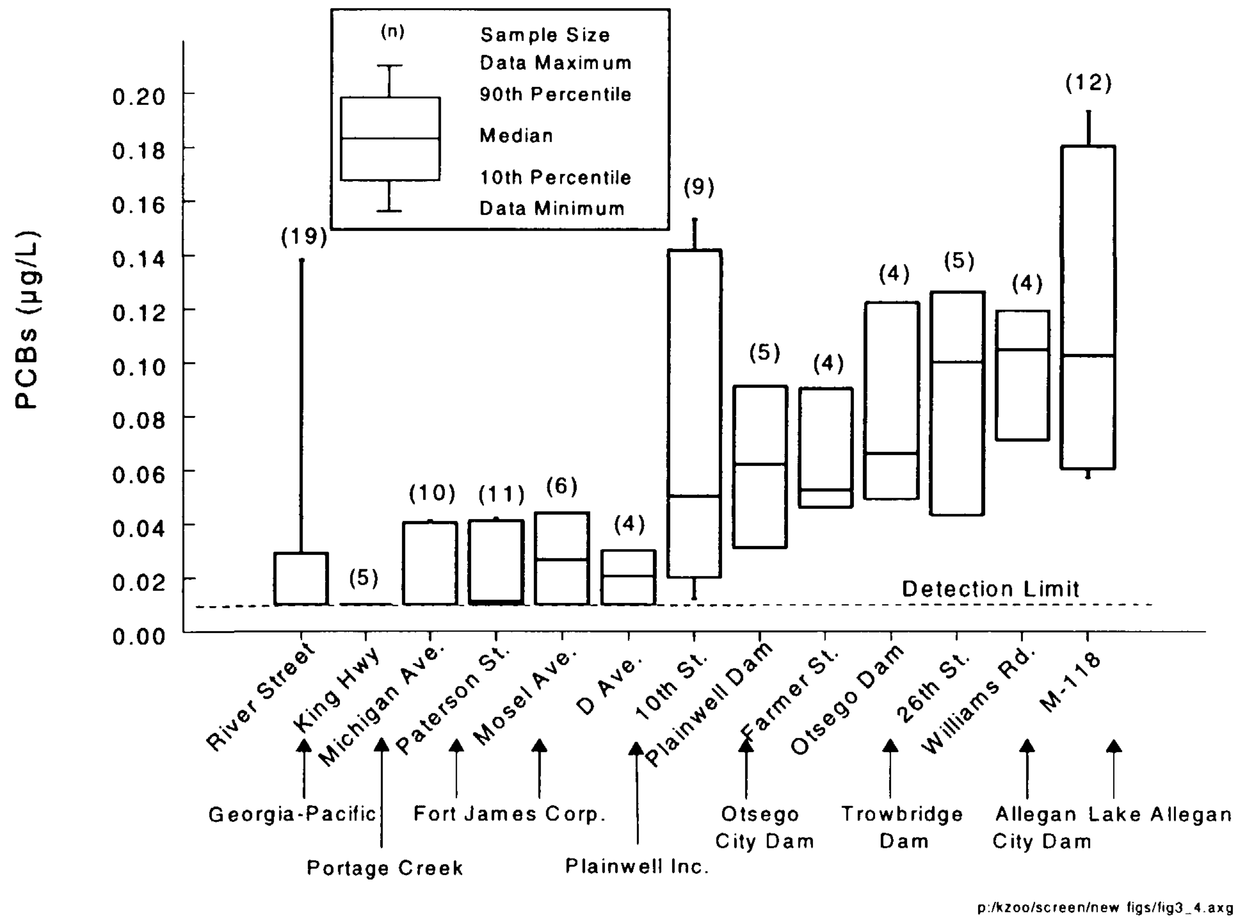


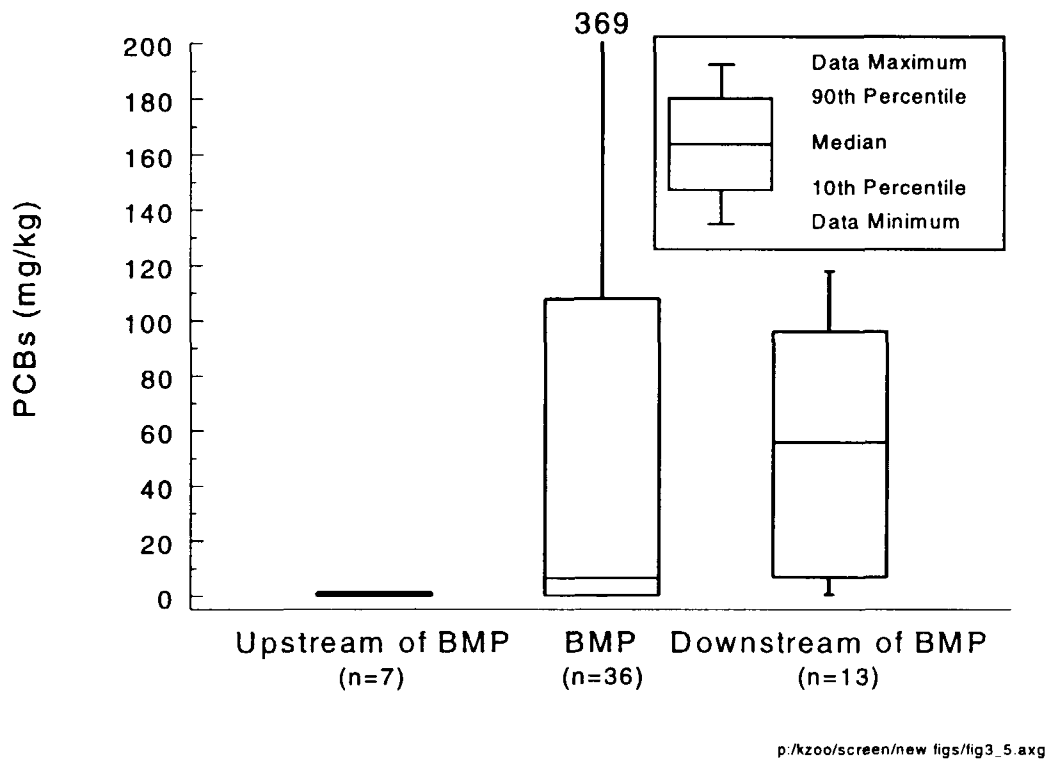
Figure 3-4
PCB Concentrations in Kalamazoo River Surface Water, 1985-1987



Downstream is to the right. The triangle at the River Street site represents a single data point. Sampling locations shown in Figure 3-3.

Source: Michigan DNR, 1987a.

Figure 3-5
PCB Concentrations in Portage Creek Surficial Sediments



Data for all sampling years and investigations are pooled. BMP = former Bryant Mill Pond. See text for data sources.

GZA/Donahue (1988, 1990), Environmental Resources Management (1989), FTC&H (1991), Bhaskar et al. (1983), Blasland, Bouck & Lee (1992, 1994f), and Horvath (1984).

Data on surficial bed sediment PCB concentrations in the Kalamazoo River include samples from upstream of Morrow Pond and in Morrow Pond, both of which are upstream of PRP paper facilities. Sediment PCB concentrations have also been measured downstream of Georgia-Pacific facilities in Kalamazoo, near Plainwell (downstream of Plainwell Inc. facilities), at the former Plainwell impoundment, at the Otsego City Dam impoundment, at the former Otsego impoundment, upstream of the former Trowbridge impoundment, at the Allegan City Dam impoundment, in Lake Allegan, and downstream of Lake Allegan (Figure 3-6).

PCB concentrations in Kalamazoo River bed sediments downstream of PRP facilities were one to two orders of magnitude greater than concentrations upstream (Figure 3-6). Upstream of the facilities, the maximum PCB concentration measured was 2.4 mg/kg, and most concentrations were less than 1 mg/kg. In contrast, concentrations of PCBs in sediments downstream were as high as 180 mg/kg at the Otsego City Dam impoundment (Michigan DNR, 1991), 67 mg/kg near Plainwell, 48 mg/kg downstream of Georgia-Pacific, 42 mg/kg in Lake Allegan, and many were greater than 10 mg/kg (Figure 3-6).

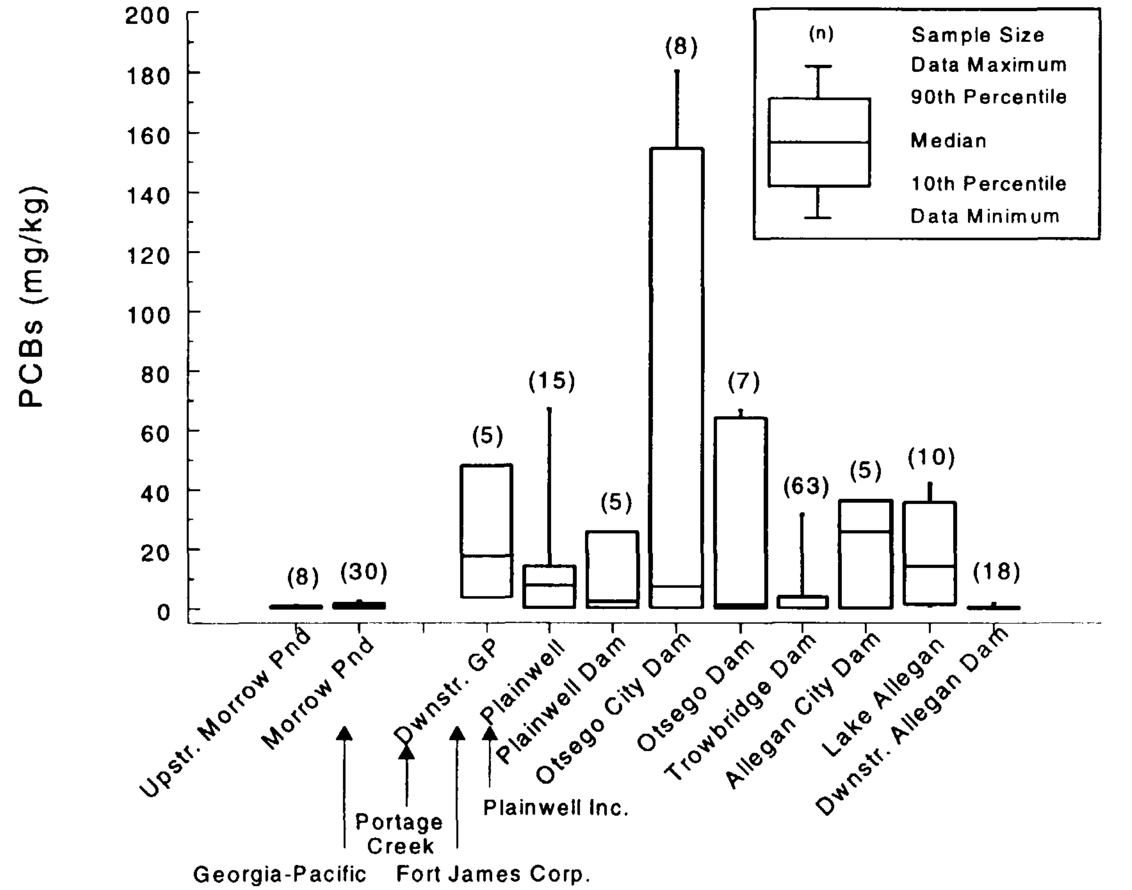
3.3.2 Floodplain Soils

Floodplain soils along Portage Creek and the Kalamazoo River have elevated PCB concentrations. Areas where contaminated sediments accumulated that are now above the water level following dam removal include the former Bryant Mill Pond impoundment on Portage Creek, and the Plainwell, Otsego, and Trowbridge former impoundments on the Kalamazoo River (Blasland, Bouck & Lee, 1992). Floodplain soils at these former impoundments were originally deposited as river sediments when the dams were in operation.

The soils at the former Bryant Mill Pond impoundment collected prior to 1998-1999 removal activities contain PCBs at concentrations as high as 1000 mg/kg (Blasland, Bouck & Lee, 1992). For comparison, PCB concentrations in floodplain soils upstream of PRP facilities in Kalamazoo ranged from below detection (at a detection limit of 0.11 mg/kg) to 0.39 mg/kg (Blasland, Bouck & Lee, 1994a). In various floodplain soil samples collected between 1983 and 1989 downstream of Kalamazoo, PCB concentrations were as high as 81 mg/kg, with many ranging between 10 mg/kg and 20 mg/kg (Georgia-Pacific, 1989; Michigan DNR, 1983, 1987a; Blasland, Bouck & Lee, 1992).

Figure 3-7 shows some example PCB concentrations in floodplain soils from several sites collected between 1983 and 1989 along the Kalamazoo River, including in the city of Kalamazoo and behind the former Plainwell, Otsego, and Trowbridge dams. Floodplain soils collected in

Figure 3-6
PCB Concentrations in Kalamazoo River Bed Sediments



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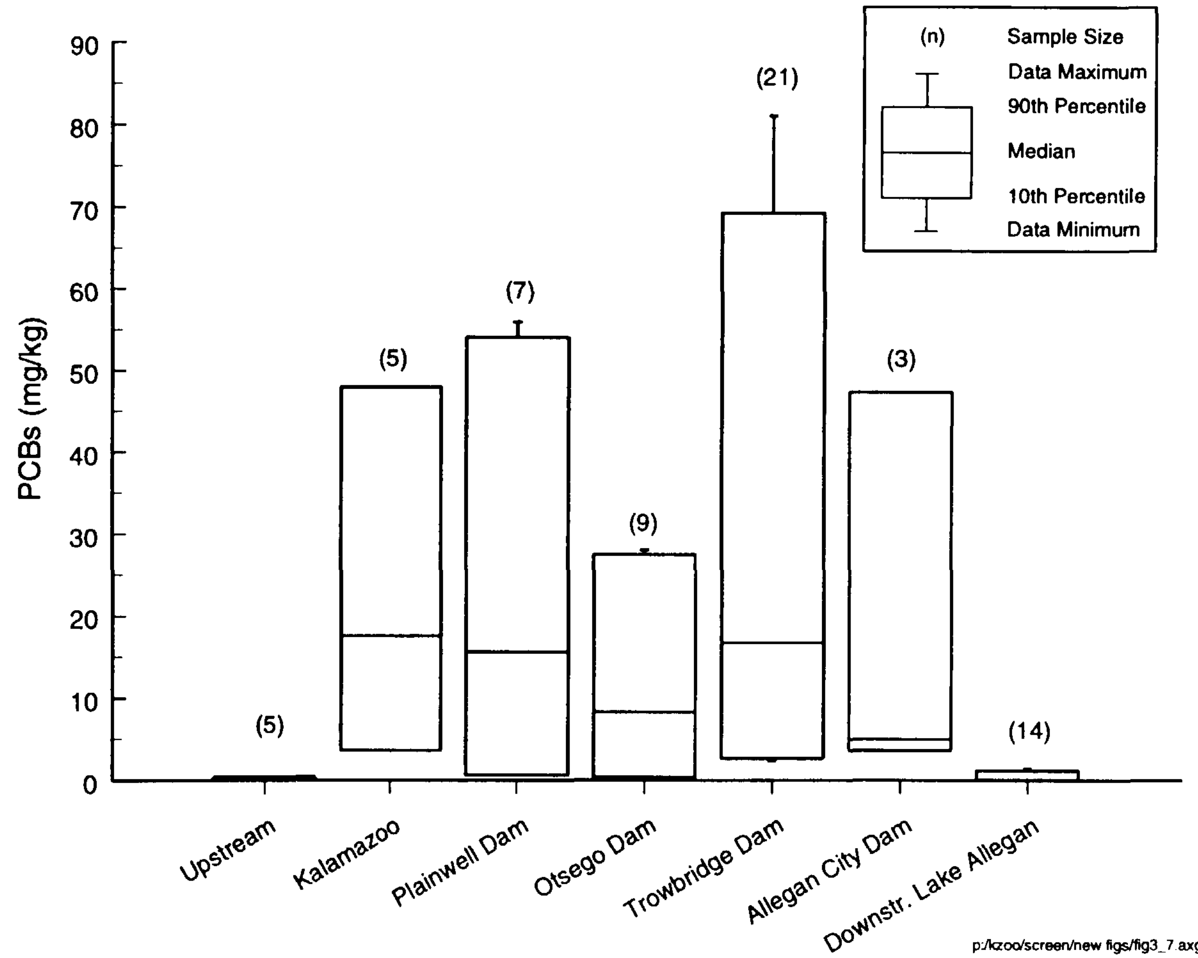
Data for all sampling years and investigations are pooled. Morrow Pond is upstream of paper company facilities. GP = Georgia-Pacific facilities. See text for data sources.

Figure 3-7
PCB Concentrations in Kalamazoo River Floodplain Soils, 1983-1989



Downstream is to the right. Data from four investigations are pooled. See text for data sources.

1993 contained PCB concentrations as high as 85 mg/kg, 36 mg/kg, and 81 mg/kg for the former impoundments of Plainwell, Otsego, and Trowbridge, respectively (Blasland, Bouck & Lee, 1994h).

3.3.3 Groundwater

PCBs have been measured in groundwater underlying various PRP facilities in the KRE. Table 3-1 presents examples of PCB concentrations measured in groundwater at or near PRP facilities where PCBs are known to be present. For comparison, background concentrations of PCBs in groundwater upgradient of Allied Paper facilities are less than the detection limit of 0.01 μg/L (Michigan DNR, 1987c). PCB concentrations in groundwater downgradient of PRP landfills have been measured at concentrations as high as 3.3 μg/L, which is at least two orders of magnitude greater than background (Table 3-1).

Table 3-1
Example PCB Concentrations in Groundwater Underlying PRP Paper Facilities

Location	PCB Concentration (μg/L)	Source
Background		
Upgradient of Allied Paper	<0.01	Michigan DNR, 1987c
Allied Paper Facilities		
Outside Type III landfill, adjacent to Portage Creek	0.52 0.56	Michigan DNR, 1987c
Northeast of Bryant HRDL, ~100 feet from Portage Creek	0.35 0.10	Blasland, Bouck & Lee, 1992
East of Bryant HRDL, ~100 feet from Portage Creek	0.13	
East of Bryant HRDL, ~20 feet from Portage Creek	0.37	
North of Bryant Clarifier, ~150 feet from Portage Creek	2.1 1.7 1.4 0.76 3.3	

3.3.4 Biota

PCB concentrations have been measured in various KRE biota, including fish, bird tissue and bird eggs, mice, earthworms, mink, and muskrat (*Ondatra zibethica*), at concentrations downstream of PRP facilities that are elevated relative to concentrations measured upstream.

Fish

Table 3-2 presents summaries of PCB concentrations measured in Kalamazoo River and Portage Creek carp fillets in 1993. Blasland, Bouck & Lee (1994b) collected carp from the area of the former Bryant Mill Pond in Portage Creek. A mark-recapture method was used to capture, tag, and release the carp. When carp were collected in the same area two to three months later, only those fish that were marked (and therefore presumably had not recently migrated into the PCB-contaminated area) were retained for PCB analysis of skinless fillets. A total of 11 fish were analyzed for PCBs. At Portage Creek, the mean PCB concentration in the skinless carp fillets was 3.4 mg/kg, and the maximum PCB concentration was 8.8 mg/kg (Table 3-2; Blasland, Bouck & Lee, 1994b).

As part of the RI/FS, Blasland, Bouck & Lee (1994a) collected and analyzed carp and smallmouth bass fillets from 11 locations along the Kalamazoo River in 1993. Eleven specimens of each species were collected from each location (without mark-recapture). PCB concentrations were measured in skinless carp fillets and skin-on smallmouth bass fillets.

The mean PCB concentration in carp upstream of the town of Battle Creek was 0.08 mg/kg, and in Morrow Pond the mean PCB concentration was 0.61 mg/kg. Carp fillets from areas downstream of paper company facilities had much higher PCB concentrations than did carp fillets from upstream of PRP facilities (Table 3-2). Mean PCB concentrations in carp fillets downstream of Morrow Pond Dam ranged from 1.8 mg/kg in Lake Allegan to 7.6 mg/kg downstream of Allegan Dam.

PCB concentrations in carp fillets remained an order of magnitude higher than those from upstream locations for the entire 80 miles of river downstream of PRP facilities to Lake Michigan (Table 3-2; Blasland, Bouck & Lee, 1994a). No consistent relationship between the distance downstream of PRP facilities and carp fillet PCB concentrations is apparent from the 1993 data. Although concentrations appear to be lower at Lake Allegan than at locations upstream of Lake Allegan, concentrations downstream of Lake Allegan were as high as or higher than concentrations from upstream. The highest concentration (17 mg/kg PCB) was measured in skinless fillets from a carp collected near Plainwell and a carp collected downstream of Lake Allegan. These data indicate that carp have been exposed to PCBs throughout the entire length of the Kalamazoo River downstream of paper company facilities.

Table 3-2
PCB Concentrations in Skinless Carp Fillets,
Kalamazoo River and Portage Creek, 1993

Location	n	Minimum PCB Concentration (mg/kg wet weight)	Mean PCB Concentration (mg/kg wet weight)	Maximum PCB Concentration (mg/kg wet weight)
Upstream of Battle Creek	11	0.055	0.08	0.17
Morrow Pond	11	0.083	0.61	1.9
Portage Creek	11	1.5	3.4	8.8
Downstream of Morrow Pond Dam	11	1.4	4.4	8.2
City of Kalamazoo	11	1.2	6.6	13.0
Downstream of Plainwell	11	1.4	5.8	17.0
Between Plainwell Dam and Otsego City Dam	11	1.1	3.5	8.0
Upstream of Otsego Dam	11	0.56	2.7	6.4
Upstream of Trowbridge Dam	11	1.3	4.6	9.6
Lake Allegan	11	0.099	1.8	6.5
Downstream of Allegan Dam	11	1.9	7.6	17.0
Saugatuck	11	1.4	5.0	9.1

n = number of samples.

Source: Blasland, Bouck & Lee, 1994a; 1994b.

In smallmouth bass fillets, PCB concentrations were also elevated downstream of paper company facilities compared to upstream (Table 3-3; Blasland, Bouck & Lee, 1994a). As with carp, no trend in smallmouth bass fillet PCB concentrations was apparent with distance downstream of the paper company facilities. The highest fillet PCB concentrations were in smallmouth bass collected from Lake Allegan (5.8 mg/kg). The lowest concentrations downstream of Morrow Pond Dam were in a bass collected from the City of Kalamazoo (0.16 mg/kg) and a bass collected near the river mouth at Saugatuck (0.13 mg/kg). These data indicate that smallmouth bass from the Kalamazoo River downstream of paper company facilities have been exposed to elevated PCB concentrations.

Table 3-3
PCB Concentrations in Skin-On Smallmouth Bass Fillets, Kalamazoo River, 1993

Location	n	Minimum PCB Concentration (mg/kg wet weight)	Mean PCB Concentration (mg/kg wet weight)	Maximum PCB Concentration (mg/kg wet weight)
Upstream of Battle Creek	11	0.049	0.14	0.31
Morrow Pond	11	0.10	0.28	0.67
Downstream of Morrow Pond Dam	11	0.38	1.1	3.2
City of Kalamazoo	11	0.16	0.48	0.72
Downstream of Plainwell	11	0.68	1.8	3.9
Between Plainwell Dam and Otsego City Dam	11	0.27	0.99	3.7
Upstream of Otsego Dam	11	0.39	1.5	3.7
Upstream of Trowbridge Dam	11	0.39	2.0	4.2
Lake Allegan	11	1.6	3.3	5.8
Downstream of Allegan Dam	11	1.1	1.9	2.4
Saugatuck	11	0.13	0.54	0.83

n = number of samples.

Source: Blasland, Bouck & Lee, 1994a.

Historical data on fish fillet PCB concentrations were obtained from the STORET database listings compiled for the Michigan fish contaminant monitoring program and from Michigan Water Resources Commission reports. Most of these data were collected by the Michigan DNR. Kalamazoo River fish PCB concentrations were first measured in 1971; additional collections took place between 1983 and 1987 (Table 3-4).

The data presented in Table 3-4 demonstrate that fish in the Kalamazoo River downstream of PRP facilities have been documented to be exposed to PCBs since as early as 1971. Table 3-2 and Table 3-3 indicate that fish continue to be exposed in 1993, but with available data it is not possible to determine exposure prior to the 1971 sampling period. PCBs were detected in fillets of all twelve species of fish [carp, northern pike (*Esox lucius*), white sucker (*Catostomus commersoni*), largemouth bass (*Micropterus salmoides*), smallmouth bass, black crappie

Table 3-4
Summary of Historical Data (prior to 1993)
on Kalamazoo River Fish Fillet PCB Concentrations
Collected Downstream of PRP Facilities

Sample Year	Species	n	Minimum PCB Concentration (mg/kg)	Mean PCB Concentration (mg/kg)	Maximum PCB Concentration (mg/kg)
1971	Carp	12	0.2	29.5	164.6
	Northern pike	7	0.1	6.9	17.6
	White sucker	11	<0.1	17.0	56.9
1983	Carp	26	<0.9	4.0	15.9
1984	Carp	11	1.0	8.5	25.7
1985	Carp	109	<0.1	4.0	14.0
	Largemouth bass	19	0.5	2.0	6.5
	Smallmouth bass	11	0.8	1.7	3.3
1986	Carp	165	<0.1	4.1	27.4
	Largemouth bass	5	<0.1	0.6	1.1
1987	Black crappie	10	0.3	0.7	1.6
	Bluegill	10	0.2	0.4	0.7
	Channel catfish	8	3.5	6.4	12.4
	Carp	47	0.1	2.7	17.1
	Largemouth bass	11	<0.1	1.0	2.0
	Northern pike	14	0.3	1.5	3.4
	Rock bass	10	0.2	0.4	0.5
	Rainbow trout	10	0.2	0.4	0.7
	Smallmouth bass	21	<0.1	1.8	5.1
	Walleye	10	0.3	0.6	1.5
	White sucker	10	0.4	1.1	2.8
	Yellow perch	10	0.1	0.4	1.2

n = number of samples.

Source: Michigan DNR, 1992; Michigan Water Resources Commission, 1972a.

(*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), channel catfish, rock bass (*Ambloplites rupestris*), rainbow trout, walleye, and yellow perch (*Perca flavescens*)] collected prior to 1993. Maximum PCB concentrations in fillets of carp (164.6 mg/kg), northern pike (17.6 mg/kg), and white sucker (56.9 mg/kg) were collected in 1971. Maximum PCB concentrations for fillets of largemouth bass and smallmouth bass collected during this sampling period range from 1.1 mg/kg in 1986 to 6.5 mg/kg in 1985 and from 3.3 mg/kg in 1985 to 5.1 mg/kg in 1987, respectively. All other species were collected only in 1987. Maximum PCB concentrations in the remaining species range from 0.5 mg/kg in rock bass to 12.4 mg/kg in channel catfish (Table 3-4).

Whole-body concentrations of PCBs have also been measured in Kalamazoo River fish as part of ongoing RI/FS activities. In carp, whole-body PCB concentrations measured in 1993 were an order of magnitude greater downstream of the Morrow Pond Dam than upstream. The maximum concentration downstream exceeded 35 mg/kg, compared to less than 1.0 mg/kg near Battle Creek (Blasland, Bouck & Lee, 1994a). Whole-body PCB concentrations were also elevated in smallmouth bass and white suckers collected downstream of the Morrow Pond Dam. The maximum smallmouth bass concentration was nearly 15 mg/kg downstream of the dam, compared to less than 1.0 mg/kg at Battle Creek. White suckers contained up to 4.5 mg/kg PCB downstream of the dam, compared to less than 0.2 mg/kg in Battle Creek (Blasland, Bouck & Lee, 1994a).

Whole-body PCB concentrations in Kalamazoo River fish are discussed in greater detail in Section 4.3.4.

Birds

Some studies have shown that various duck species (*Anas* spp.) have accumulated PCBs in edible tissues. These studies include Michigan DNR (1987a), Michigan Department of Public Health (1990), and Blasland, Bouck & Lee (1992). Table 3-5 shows lipid-normalized PCB concentrations measured in tissues of mallards (*Anas platyrhynchos*), wood ducks (*Aix sponsa*), a merganser (*Mergus* spp.), a Canada goose (*Branta canadensis*), and a blue-winged teal (*Anas discors*) collected in the KRE. PCB concentrations as high as 700 mg/kg lipid have been measured in a merganser at Morrow Pond (Table 3-5). Lipid-normalized concentrations of PCBs measured in mallards, wood ducks, blue-winged teal, and a Canada goose from the KRE range as high as 73, 36.6, 9.6, and 6.4 mg/kg lipid, respectively (Table 3-5).

PCBs have been measured in the eggs of KRE birds as well. Bald eagles and great blue herons are both primarily fish-eating birds (U.S. EPA, 1993). In 1994, a single bald eagle egg (which did not hatch) was collected from a nest in Ottawa Marsh, approximately six miles downstream of Lake Allegan Dam (D. Best, U.S. Fish and Wildlife Service, pers. comm., 1997). The egg contained 102 mg/kg PCBs, more than three times greater than the 1986-1990 average PCB concentration in the eggs of bald eagles that nest along Lake Michigan (Kubiak and Best, 1991). In 1996, two bald eagle eggs collected in the Allegan State Game Area had PCB concentrations

Table 3-5
PCB Concentrations in the Fat of KRE Ducks and Geese

Location	Species	Measured PCB Concentration (mg/kg lipid)	Source
Morrow Pond (upstream of paper companies)	Merganser	700	Michigan DNR, 1987a
Otsego City Dam Impoundment	Mallard	68	Blasland, Bouck & Lee, 1992
	Mallard	65	
	Blue-winged teal	9.6	
Former Trowbridge Impoundment	Mallard	68	Blasland, Bouck & Lee, 1992
	Mallard	73	
Lake Allegan	Wood duck	36.6	Blasland, Bouck & Lee, 1992
	Canada goose	6.4	
Pottawatamie Marsh	Mallard	1.8	Michigan Dept. of Public Health, 1990
	Mallard	7.7	
Saugatuck	Mallard	11.8	Michigan DNR, 1987a
	Mallard	9.3	
	Mallard	7.1	
	Mallard	10.7	
	Mallard	23.0	
	Mallard	11.9	
	Mallard	48.7	
	Wood duck	2.7	
	Mallard	30.3	
	Mallard	36.3	

of 53 and 32 mg/kg (D. Best, U.S. Fish and Wildlife Service, personal communication, 2000). In 1993, six great blue heron eggs were collected from the Ottawa Marsh. The great blue heron egg PCB concentrations measured in 1993 ranged from 1.48 mg/kg to 44.38 mg/kg. Table 3-6 presents the results of the PCB analyses of these eggs. The significance of these egg PCB concentrations is discussed in Section 4.3.5.

Table 3-6
PCB Concentrations in KRE Bald Eagle and Great Blue Heron Eggs

Species	Collection Year	Collection Location	PCB Concentration (mg/kg wet weight)	Source
Bald Eagle	1994	Ottawa Marsh	102	D. Best, U.S. Fish and Wildlife Service, pers. comm., 1997
Great Blue Heron	1993	Ottawa Marsh	1.48	Mehne, 1994
			2.3	
			2.31	
			4.74	
			7.67	
			44.38	
Bald Eagle	1996	Allegan State Game Area	53.34	D. Best, U.S. Fish and Wildlife Service, pers. comm., 2000
			31.68	

PCBs have also been detected in the eggs and tissues of nonpiscivorous raptors in the KRE, including great horned owls and red-tailed hawks. PCBs measured in great horned owl eggs indicate that KRE owls are being exposed to and accumulating PCBs. One great horned owl egg was collected in 1993 and one in 1994 from the Allegan State Game Area downstream of Lake Allegan and analyzed for PCBs (Mehne, 1994). PCB concentrations in the two great horned owl eggs were 15.94 mg/kg and 90.8 mg/kg (Table 3-7).

Like great horned owls, red-tailed hawks in the KRE have been exposed to PCBs. A red-tailed hawk egg collected from the Allegan State Game Area in 1993 contained 2.31 mg/kg PCBs, and two eggs collected in 1994 contained 4.47 and 27.12 mg/kg (Table 3-7). The significance of the PCB concentrations in red-tailed hawk and great horned owl eggs is discussed further in Section 4.3.5.

Table 3-7
PCB Concentrations in KRE Great Horned Owl and Red-Tailed Hawk Eggs

Species	Tissue	Year Collected	Collection Location	PCB Concentration (mg/kg wet weight)
Great Horned Owl	Egg	1993	Allegan State Game Area	90.8
		1994	Allegan State Game Area	15.94
Red-Tailed Hawk	Egg	1993	Allegan State Game Area	2.31
		1994	Allegan State Game Area	4.47
		1994	Allegan State Game Area	27.12

Source: Mehne, 1994.

Mice and Earthworms

A 1993 RI/FS study showed that PCB concentrations were higher in whole bodies of white-footed mice (*Peromyscus leucopus*) and earthworms collected from floodplains downstream of PRP paper facilities than in those collected in Battle Creek, upstream of the facilities (Blasland, Bouck & Lee, 1994a). Upstream of PRP facilities, PCBs were not detected in any of the 10 mice collected. Downstream of PRP facilities, PCBs were detected in 70% to 100% of the mice collected at four locations where floodplain soils are contaminated with PCBs (Table 3-8). PCB concentrations as high as 0.45 mg/kg were detected in whole bodies of white-footed mice collected downstream of PRP facilities.

No PCBs were detected in any of the three composite samples of earthworms collected from floodplain soils upstream of PRP facilities (Table 3-9). Downstream of PRP facilities, PCBs were detected in 100% of the earthworm samples, at concentrations up to 3.2 mg/kg.

PCBs that are accumulating in mice and earthworms downstream of PRP facilities can be transferred to their predators. White-footed mice predators in the KRE include great horned owls and red-tailed hawks, and earthworms are primary prey items for American robins and American woodcocks (U.S. EPA, 1993).

Table 3-8
PCB Concentrations (mg/kg wet weight) in Whole-Body White-Footed Mice Collected in 1993 from Kalamazoo River Floodplains

Location	Number of Samples	Median[a] (range)	% Detect
Battle Creek (upstream of paper companies)	10	nd	0%
Former Plainwell Impoundment	10	0.11 (nd-0.28)	70%
Downstream of Otsego Dam	10	0.28 (0.089-0.38)	100%
Former Trowbridge Impoundment	10	0.115 (nd-0.45)	80%
Allegan Dam	10	0.036 (nd-0.35)	80%

a. Median of detected concentrations.
nd = Not detected at detection limits ranging from 0.011 to 0.098 mg/kg wet weight.

Source: Blasland, Bouck & Lee, 1994a.

Table 3-9
PCB Concentrations (mg/kg wet weight) in Earthworms from Kalamazoo River Floodplains

Location	Number of Samples	Median (range)	% Detect
Battle Creek (upstream of paper companies)	3	nd	0%
Former Plainwell Impoundment	3	0.59 (0.13-0.66)	100%
Downstream of Otsego Dam	3	2.2 (1.3-2.2)	100%
Former Trowbridge Impoundment	3	2.5 (2.1-3.2)	100%
Allegan Dam	3	0.024 (0.23-0.25)	100%

nd = Not detected at detection limits ranging from 0.05 to 0.25 mg/kg wet weight.

Source: Blasland, Bouck & Lee (1994a).

Mink

Recent data show that mink downstream of paper company facilities are exposed to and accumulate PCBs. In 1993, the Michigan DNR collected 10 mink from five locations along the Kalamazoo River and analyzed each of the carcasses and livers for PCBs (CDM, 1993; Roy F. Weston Inc., 1994). These data show that mink collected from PCB-contaminated areas downstream of paper company facilities (near Trowbridge, Plainwell, and Allegan dams) contain higher concentrations of PCBs than do mink from upstream areas (Table 3-10). For example, liver PCB concentrations in mink from upstream of Battle Creek range from 1.2 to 6.0 mg/kg (dry weight), whereas concentrations in mink from the downstream areas range from 7.5 to 52 mg/kg (dry weight).

Table 3-10
PCB Concentrations (mg/kg dry weight) in KRE Mink

Location	Number of Samples	Median (range)	% Detect
Mink Carcass			
Battle Creek (upstream of paper companies)	5	3.0 (1.9-6.5)	100%
Former Plainwell Impoundment	1	7.6	100%
Former Trowbridge Impoundment	2	13.5 (11.0-16.0)	100%
Allegan Dam	2	8.6 (5.2-12.0)	100%
Mink Liver			
Battle Creek (upstream of paper companies)	5	3.3 (1.2-6.0)	100%
Former Plainwell Impoundment	1	11.0	100%
Former Trowbridge Impoundment	1	7.5	100%
Allegan Dam	2	30.5 (9.0-52.0)	100%

Source: Roy F. Weston Inc., 1994.

Muskrat

In 1994, the Michigan DNR collected muskrat from five locations along the Kalamazoo River: one upstream of Battle Creek and four downstream of paper company facilities (Roy F. Weston Inc., 1994). Six muskrat were trapped at each location. PCBs were measured in the liver and carcass of each animal collected. PCBs were not detected in the carcass or liver of any of the muskrat from the Battle Creek location (upstream of paper companies), at detection limits ranging from 0.12 to 0.59 mg/kg (dry weight) (Table 3-11). At the locations downstream of paper companies, PCBs were detected in 23 livers and 23 carcasses (Table 3-11). The maximum PCB concentrations in carcass (8.4 mg/kg dry weight) and liver (3.8 mg/kg dry weight) were measured in muskrat collected near the former Trowbridge impoundment.

Table 3-11
PCB Concentrations (mg/kg dry weight) in KRE Muskrat

Location	Number of Samples	Median (range)	% Detect
Muskrat Carcass			
Battle Creek (upstream of paper companies)	6	nd	0%
Former Plainwell Impoundment	6	1.0 (0.081-2.0)	100%
Former Otsego Impoundment	6	0.46 (0.14-0.99)	100%
Former Trowbridge Impoundment	6	0.58 (0.28-8.4)	100%
Allegan Dam	6	1.9 (nd-3.1)	83%
Muskrat Liver			
Battle Creek (upstream of paper companies)	6	nd	0%
Former Plainwell Impoundment	6	0.93 (0.12-2.6)	100%
Former Otsego Impoundment	6	0.40 (0.12-1.0)	100%
Former Trowbridge Impoundment	5[a]	1.4 (0.23-3.8)	100%
Allegan Dam	6	1.4 (0.33-1.9)	100%

nd = Not detected at detection limits ranging from 0.12 to 0.59 mg/kg.
a. One muskrat liver sample from this location was lost in processing.

Source: Roy F. Weston Inc., 1994.

These data show that muskrat from areas downstream of paper companies are exposed to PCBs at concentrations higher than muskrat in areas upstream of paper company locations.

3.4 POTENTIALLY AFFECTED RESOURCES [43 CFR § 11.25(e)(1)]

The data presented in this chapter support the conclusion that natural resources for which the Trustees have trusteeship and that have been affected or potentially affected by releases of hazardous substances from the PRP facilities include, but are not limited to, the following:

- surface water resources, including surface water and sediments (bed, bank, and shoreline) of Portage Creek, the Kalamazoo River, and Lake Michigan
- groundwater and aquifer materials at and downgradient of PCB disposal areas
- soils, including floodplain soils adjacent to Portage Creek and the Kalamazoo River
- aquatic biota resources, including several species of fish
- terrestrial biota resources, including several species of mammals and birds.

3.5 PRELIMINARY ESTIMATE OF AFFECTED SERVICES [43 CFR § 11.25(e)(2)]

Services provided or potentially provided by the resources identified in Section 3.4 include, but are not limited to the following:

- habitat for fish and wildlife, including food, shelter, breeding and rearing areas, and other factors essential to long-term survival
- consumptive and non consumptive outdoor recreation, including fishing, hunting, trapping, wildlife viewing, and photography
- primary and secondary contact recreation, including swimming, boating, and other activities
- use, option, and bequest values related to all of the above services
- nonuse values, including existence values, related to all of the above services.

CHAPTER 4
DETERMINATION CRITERIA
[43 CFR § 11.23(e)]

This chapter presents an evaluation of the preassessment determination criteria [43 CFR § 11.23(e)]. The information presented and summarized in this chapter confirms the following:

- A release of hazardous substances has occurred.

- Natural resources for which the Trustees have trusteeship have been or are likely to have been adversely affected.

- The quantity and concentration of the released hazardous substances are sufficient to potentially cause injury.

- Data sufficient to pursue an assessment are readily available or likely to be obtained at reasonable cost.

- Response actions will not sufficiently remedy the injury to natural resources without further action.

Based on the evaluation of the criteria presented below, the Trustees have determined that a Type B NRDA should be performed to assess damages to natural resources caused by releases of PCBs from PRP facilities in the Kalamazoo River basin. The justification of the decision to perform a Type B NRDA will be presented in the Assessment Plan.

4.1 A RELEASE OF HAZARDOUS SUBSTANCES HAS OCCURRED

Releases of PCBs, a hazardous substance, from facilities in the KRE belonging to Allied Paper, Georgia-Pacific, Plainwell Inc., and the Fort James Corporation, have been well documented. Numerous investigators, including the Michigan Water Resources Commission, the Michigan DNR, Georgia-Pacific, and various contractors have demonstrated that multiple and at times continuous releases and re-releases of PCBs have occurred and continue to occur as a result of operations at PRP paper facilities (Section 2.4). These investigators have also documented elevated concentrations of PCBs in KRE surface water, sediments, groundwater, soils, and biota that have resulted from releases of PCBs into the KRE.

4.2 TRUSTEE NATURAL RESOURCES HAVE BEEN OR ARE LIKELY TO HAVE BEEN ADVERSELY AFFECTED BY THE RELEASE

Natural resources [as defined in 43 CFR § 11.14(z)] for which the Trustees have trusteeship that have been or are likely to have been adversely affected by releases of hazardous substances include, but are not necessarily limited to, surface water, groundwater, geological, and biological resources.

Chapter 3 presents data confirming elevated PCB concentrations in Trustee natural resources. Section 4.3 confirms that this exposure is at concentrations and duration sufficient to potentially injure natural resources.

4.3 THE QUANTITY AND CONCENTRATION OF THE RELEASED HAZARDOUS SUBSTANCES ARE SUFFICIENT TO POTENTIALLY CAUSE INJURY

4.3.1 Surface Water/Sediments

Surface water resources are defined as including surface water, suspended sediment, and bed, bank, and shoreline sediments [43 CFR§11.62(b)(1)(i)(pp)]. However, because injury to surface water and sediment in the KRE can be evaluated using different injury criteria, we evaluate the potential for PCBs to cause injury separately for surface water and sediment.

Surface Water

Relevant definitions of injury to surface water include the following:

- concentrations of hazardous substances exceeding Safe Drinking Water Act (SDWA) or other relevant federal or state criteria or standards for drinking water [43 CFR § 11.62(b)(1)(i)]

- concentrations and duration of substances in excess of applicable water quality criteria established by Section 304(a)(1) of the Clean Water Act (CWA), or by other Federal or State laws or regulations that establish such criteria. . . in surface water that before the discharge or release met the criteria and is a committed use . . . as a habitat for aquatic life, water supply, or recreation [43 CFR § 11.62(b)(1)(iii)]

- concentrations and duration of hazardous substances sufficient to have caused injury to biological resources when exposed to surface water [43 CFR § 11.62(b)(1)(v)].

The mainstem of the Kalamazoo River has been designated by the State for the following uses: agriculture, industrial water supply, navigation, public water supply, warmwater fishery, other indigenous aquatic life, wildlife, and total body contact (Michigan DNR, 1987a). Therefore, the Kalamazoo River has a designated committed use, and exceedences of applicable water quality criteria or standards constitute an injury, provided that the water met the criteria or standards prior to the release [43 CFR § 11.62(b)(iii)].

Table 4-1 lists specific regulatory criteria and standards that can be used to evaluate injury to surface waters, as defined in 43 CFR § 11.62(b). Criteria include those established to protect drinking water supplies, aquatic life, and wildlife. The Safe Drinking Water Act maximum contaminant level for PCBs is 0.5 μg/L, and the maximum contaminant level goal is 0 μg/L. Pursuant to Section 304 of the CWA, the U.S. EPA has established ambient water quality criteria (AWQC) for the protection of aquatic life. For PCBs, the AWQC is 0.014 μg/L for chronic exposure. The National Toxics Rule, which establishes water quality standards for selected states (including Michigan), adopts the AWQC value of 0.014 μg/L PCBs for aquatic life and also establishes a value of 0.00017 μg/L for human cancer risk. The Great Lakes Water Quality Guidance has issued a surface water PCB guideline of 2.6×10^{-5} μg/L based on human cancer risk and a guideline of 0.00012 μg/L as protective of wildlife. The State of Michigan has established a water quality standard of 2.6×10^{-5} μg/L PCBs based on a cancer risk value and a standard of 0.00012 μg/L PCBs for the protection of wildlife.

Table 4-1
Surface Water Criteria and Standards Established for Total PCBs

Source	Standard or Criterion (μg/L)
Safe Drinking Water Act Maximum Contaminant Level (40 CFR §141)	0.5
Safe Drinking Water Act Maximum Contaminant Level Goal[a]	0
U.S. EPA Ambient Water Quality Criteria Chronic Value[b]	0.014
National Toxics Rule[c]	0.00017 (human cancer risk) 0.014 (aquatic life)
Great Lakes Water Quality Guidance[d]	0.000026 (human cancer risk) 0.00012 (wildlife)
Michigan Water Quality Standards Rule 323.1057[e]	0.000026 (human cancer risk) 0.00012 (wildlife)

a. U.S. EPA (1995).
b. U.S. EPA (1999).
c. 63 FR 61181-61196; 62 FR 42159-42208; U.S. EPA (1999).
d. 62 FR 11723-11731; 62 FR 52921-52924.
e. Michigan DEQ (1999b).

The surface water data presented in Section 3.3.1 show that the lower 5 kilometers (3 miles) of Portage Creek and the Kalamazoo River from Morrow Pond Dam to Lake Michigan contain PCBs at concentrations that exceed the criteria and standards listed in Table 4-1. In Portage Creek downstream of the Allied Paper facilities, PCB concentrations in 21 of 24 samples collected as part of the RI/FS exceeded all of the injury thresholds in Table 4-1 except the SDWA standard (Blasland, Bouck & Lee, 1994b). Concentrations in the other two samples were not detected at a detection limit of 0.025 μg/L, which is greater than almost all of the injury thresholds in Table 4-1 and thus does not allow for conclusions regarding threshold exceedences. The maximum concentration measured, 0.23 μg/L, exceeded the chronic AWQC by an order of magnitude and the state standard, the National Toxics Rule human cancer value, and the Great Lakes Water Quality Guidance value by many orders of magnitude. Similarly, the Michigan DNR (1987a) found detectable PCB concentrations in all 27 surface water samples collected in the mid-1980s from Portage Creek downstream of Allied Paper, with concentrations in all samples exceeding criteria and standards listed in Table 4-1. Surface water data collected in 1994 followed a similar pattern, with PCBs detected above injury thresholds in all 30 samples and a maximum concentration of 0.22 μg/L (Blasland, Bouck & Lee, 1995).

PCB concentrations measured between 1985 and 1987 in the Kalamazoo River downstream of PRP facilities exceeded all the criteria and standards listed in Table 4-1 in every sample collected downstream of 10th Street (Figure 4-1). Between Michigan Avenue and 10th Street, PCB concentrations were detected at concentrations above all of the injury thresholds in 17 of 31 samples; PCBs were not detected in the other 14 samples at a detection limit of 0.01 μg/L, a concentration greater than most of the injury thresholds (Michigan DNR, 1987a; Section 3.3.1 of this document). Kalamazoo River samples were also collected in 1994 using a detection limit of 0.025 μg/L (Blasland, Bouck & Lee, 1995), which is greater than nearly all of the injury thresholds. Nevertheless, PCBs were detected in 37 of 143 samples collected, demonstrating exceedences of relevant criteria and standards.

These data demonstrate that PCB concentrations in KRE surface waters downstream of PRP facilities consistently have exceeded relevant injury thresholds, indicating that PCB concentrations are sufficient to potentially cause injury to surface water resources.

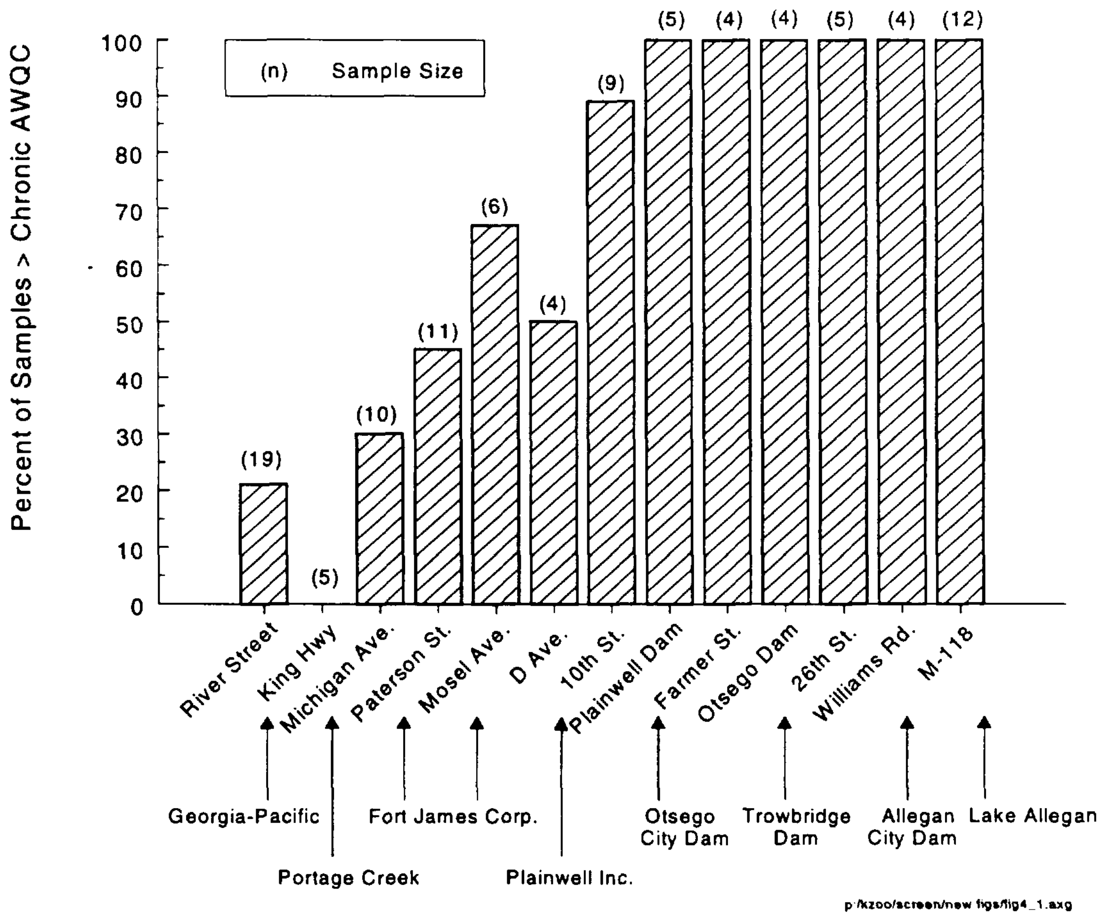
Sediments

The relevant definition of injury to sediments is

- concentrations of hazardous substances sufficient to have caused injury to biological resources that are exposed to sediments [43 CFR §11.62(b)(v)].

PCBs in sediment can cause injury to biological resources through causing toxicity to sediment-dwelling benthic macroinvertebrates or through bioaccumulating in the aquatic food chain and causing toxicity to higher-level predators.

Figure 4-1
Percent of Surface Water Samples Collected from the Kalamazoo River between 1985 and 1987 that Exceed the Chronic AWQC



To evaluate the potential for sediment PCBs to cause toxicity to benthic macroinvertebrates, several different regulatory agencies or research groups have developed sediment effects concentrations (SECs). These SECs are intended to provide a means of evaluating the potential for contaminated sediment to cause toxicity to aquatic biota. Examples of SECs are:

- Ontario Ministry of the Environment Guidelines for the Protection and Management of Aquatic Sediment (Persaud et al., 1993)
- U.S. EPA ARCS Program Sediment Effects Concentrations (Ingersoll et al., 1996; U.S. EPA, 1996)
- NOAA Effects Ranges (Long and Morgan, 1991)

- Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (Smith et al., 1996)

- Interim Criteria for Quality Assessment of St. Lawrence River sediment (Environment Canada, 1992).

All of the SECs are empirically based, relying on databases of sediment contamination and effects to invertebrates. The SECs differ in the underlying databases used, the statistical approaches employed to derive SECs from the databases, and the interpretations of the results of the statistical approaches.

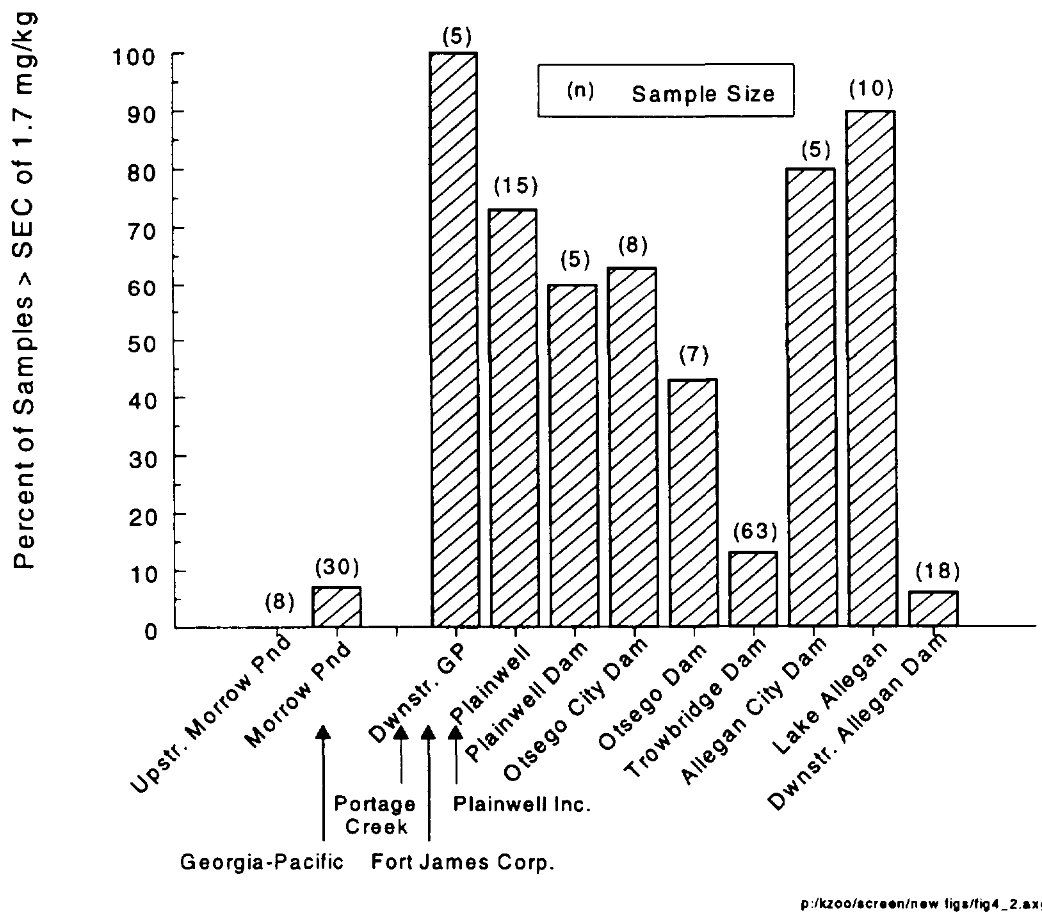
MacDonald (1999) developed "consensus-based" SECs for PCBs that are based on the existing SECs that have been developed by the different agencies and researchers. The consensus-based SECs were derived by estimating the central tendency of existing SECs, thereby "reconciling the guidance values that have been derived using various empirically-based approaches" (MacDonald, 1999). MacDonald (1999) developed three different levels of SECs for PCBs: a threshold effect concentration of 0.004 mg/kg (dry weight), which is intended to be the concentration below which adverse effects are unlikely; a mid-range effect concentration of 0.4 mg/kg (dw), which is intended to be the concentration above which adverse effects are frequently observed; and an extreme effect concentration of 1.7 mg/kg (dw), which is the concentration above which adverse effects are usually or always observed.

Using a database of sediment contaminant concentrations and observed effects, MacDonald (1999) evaluated the predictive ability of the consensus SECs in freshwater sediment. Of the samples with PCB concentrations less than the threshold effect concentration, 84% were not toxic. Of the samples with PCB concentrations greater than the mid-range and extreme effect concentrations, 68% and 83%, respectively, were toxic. These data show that the consensus-based SECs are effective at predicting the toxicity of PCBs in freshwater sediments. Therefore, we used the consensus-based SECs as potential injury thresholds for evaluating injury to benthic macroinvertebrates.

Data presented in Section 3.3.1 show that sediments in the lower 5 kilometers (3 miles) of Portage Creek and the Kalamazoo River from Morrow Pond Dam to Lake Allegan contain PCB concentrations well in excess of the SECs for benthic macroinvertebrates. In Portage Creek, including at the former Bryant Mill Pond, PCB concentrations in the majority of sediment samples collected between 1972 and 1994 exceed the 0.4 mg/kg mid-range effect concentration and the 1.7 mg/kg extreme effect concentration (Michigan Water Resources Commission, 1973b; Michigan DNR, 1983, 1984, 1987a; GZA/Donahue, 1990; Blasland, Bouck & Lee, 1992, 1994f). Portage Creek sediment concentrations from the former Bryant Mill Pond prior to removal activities have been measured as high as 369 mg/kg, approximately 900 and 200 times higher than the mid-level and extreme effect concentrations, respectively.

Sediments in the Kalamazoo River downstream of PRP facilities also contain PCB concentrations in excess of the potential thresholds for injury to benthic macroinvertebrates. Figure 3-6 and Figure 4-2 show that PCB concentrations greater than the 0.4 mg/kg mid-range effect concentration and 1.7 mg/kg extreme effect concentration have been measured downstream of Georgia-Pacific (Environmental Resources Management, 1989), in Plainwell (Michigan DNR, 1987a), in the former Plainwell Dam area (Michigan DNR, 1983), behind the Otsego City Dam (Bhaskar et al., 1983; Blasland, GZA/Donahue, 1990; Michigan DNR, 1991; Bouck & Lee, 1992), in the former Otsego Dam area (Michigan DNR, 1987a), in the former Trowbridge Dam area (Bhaskar et al., 1983; Michigan DNR, 1983; Blasland, Bouck & Lee, 1992), behind the Allegan City Dam (Bhaskar et al., 1983), and in Lake Allegan (Michigan DNR, 1983; Bhaskar et al., 1983; Blasland, Bouck & Lee, 1992). Some PCB concentrations exceeded the potential injury thresholds by an order of magnitude or greater, including 180 mg/kg near the Otsego Dam (Michigan DNR, 1991), 67 mg/kg near Plainwell (Michigan DNR, 1987a), 48 mg/kg downstream of Georgia-Pacific (Environmental Resources Management, 1989), and 42 mg/kg in Lake Allegan (Blasland, Bouck & Lee, 1992).

Figure 4-2
Percent of Kalamazoo River Bed Sediment Samples Collected between 1976 and 1993 that Exceed the SEC of 1.7 mg/kg PCBs



p:/kzoo/screen/new figs/fig4_2.axg

In addition to causing injury to benthic macroinvertebrates, PCBs in sediment can also cause injury to higher trophic level organisms through bioaccumulation in the food chain. No sediment quality guidelines or effect concentrations are available for predicting injuries through the food chain exposure route. In general, however, PCB food chain effects are predicted to occur at sediment concentrations much lower than those that cause direct toxicity to benthic macroinvertebrates (Wisconsin DNR, 1993). Therefore, since sediment PCB concentrations in the KRE downstream of paper company facilities exceed concentrations predicted to cause toxicity to benthic macroinvertebrates, they also exceed concentrations expected to cause injury via the food chain pathway.

Therefore, PCB concentrations in sediments downstream of PRP facilities have exceeded relevant sediment effects concentrations, indicating that PCB concentrations are sufficient to potentially cause injury to biological resources that are exposed to sediments.

4.3.2 Geologic Resources

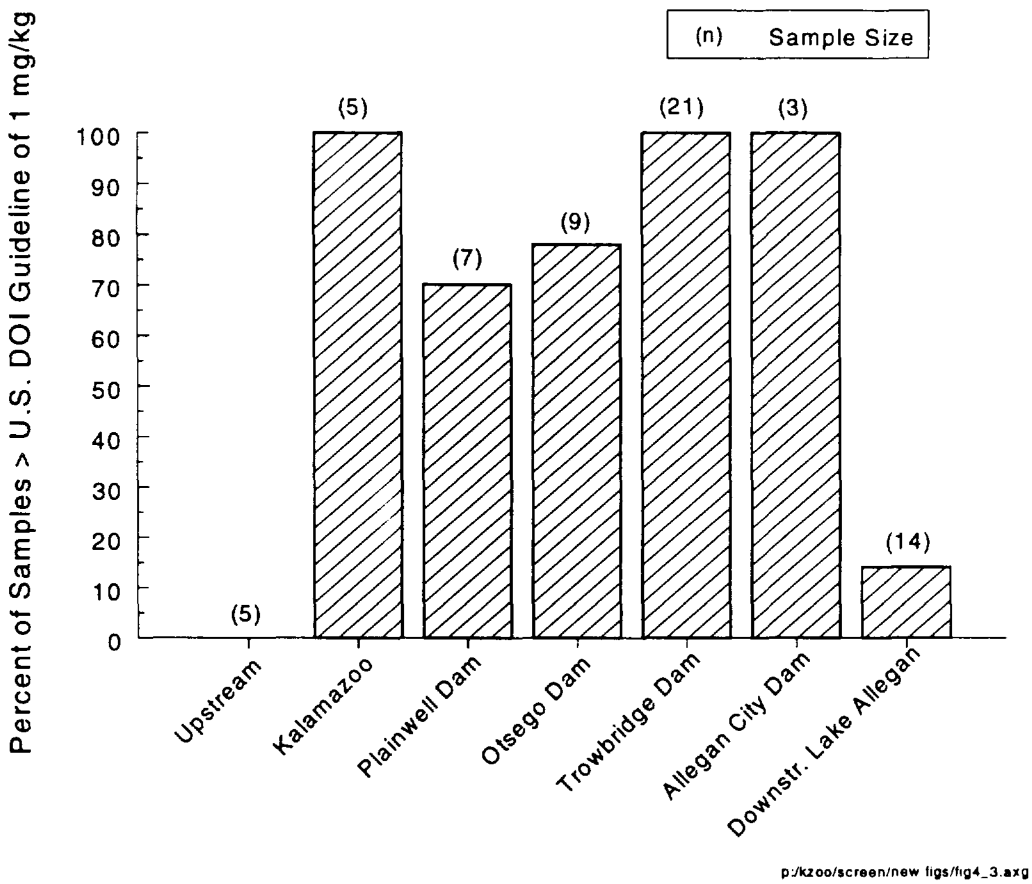
Relevant injury definitions for geologic resources (e.g., floodplain soils) include the following:

- concentrations of substances sufficient to have caused injury to surface water, groundwater, air or biological resources when exposed to the substances [43 CFR § 11.62(e)(11)].

The U.S. DOI (as cited in U.S. EPA, 1990) has recommended that soil levels of PCBs not exceed 1.0 mg/kg for the protection of wildlife. However, the U.S. EPA recommends in-depth analysis at sites where this pathway may be of particular significance (U.S. EPA, 1990). The 1.0 mg/kg recommended threshold is not specified in the U.S. DOI regulations for conducting NRDAs, and therefore an exceedence of 1.0 mg/kg PCBs in soils does not necessarily constitute injury. However, the 1.0 mg/kg U.S. DOI guideline can be used to evaluate potential injuries and the potential for floodplain soils to act as a pathway for injury to biota.

Floodplain soils in former impoundments along Portage Creek and the Kalamazoo River contain PCB concentrations well in excess of 1.0 mg/kg. Section 3.3.2 shows that PCB concentrations in soils exceed 1.0 mg/kg in several areas, including upstream of the Bryant Mill Dam on Portage Creek, and upstream of the Plainwell, Otsego, and Trowbridge dams on the Kalamazoo River (see Figure 3-7 and Figure 4-3; Blasland, Bouck & Lee, 1992, 1994d, 1994f). Prior to the removal action, the soils at the former Bryant Mill Pond impoundment contained PCB concentrations as high as 140 mg/kg (Blasland, Bouck & Lee, 1994f). Floodplain soils from former impoundments along the Kalamazoo River contain PCB concentrations as high as 85 mg/kg, with concentrations in many samples of 10 mg/kg or 20 mg/kg (Georgia-Pacific, 1989; Michigan DNR, 1983, 1987a; Blasland, Bouck & Lee, 1992, 1994h). These concentrations are at least one order of magnitude greater than the U.S. DOI recommended threshold of 1.0 mg/kg. These data demonstrate that

Figure 4-3
Percent of Kalamazoo River Floodplain Soil Samples Collected between 1983 and 1989 that Exceed the U.S. DOI Guideline



floodplain soils from former impoundments downstream of PRP facilities have exceeded the relevant injury threshold, indicating that PCB concentrations in floodplain soils are sufficient to potentially serve as a pathway for injury to biota.

4.3.3 Groundwater

Relevant definitions of injury to groundwater resources include the following:

- concentrations of hazardous substances exceeding SDWA or other relevant federal or state criteria or standards [43 CFR § 11.62(c)(1)(i), (ii), (iii)]

- concentrations of hazardous substances sufficient to cause injury to other natural resources that come in contact with the groundwater (e.g., surface water) [43 CFR § 11.62(c)(1)(iv)].

The Maximum Contaminant Level (MCL) established under Section 1416 of the SDWA for PCBs in drinking water is 0.5 μg/L [56 FR 3594]. The State has adopted the MCL of 0.5 μg/L for state drinking water standards. In addition, the U.S. EPA (1995) lists PCBs as a class B2 probable carcinogen and has established a Maximum Contaminant Level Goal (MCLG) of 0 μg/L for PCBs in groundwater.

Groundwater underlying PRP landfills and HRDLs contains PCBs at concentrations that exceed the MCL and the MCLG (see Table 3-2). For example, several groundwater samples taken from the Allied Paper facilities adjacent to Portage Creek have contained PCBs at concentrations as high as 3.3 μg/L, 2.1 μg/L, and 0.56 μg/L (Michigan DNR, 1987c; Blasland, Bouck & Lee, 1992). These concentrations exceed the MCL of 0.5 μg/L and the MCLG of 0 μg/L, indicating that groundwater at and near PRP facilities is potentially injured.

4.3.4 Fish

According to U.S. DOI regulations [43 CFR § 11.62(f)], an injury to biological resources (e.g., fish) has resulted from the discharge of a hazardous substance if the concentration of the hazardous substance is sufficient to:

- exceed action or tolerance levels established under Section 402 of the Food, Drug and Cosmetic Act (21 U.S.C. 342) in edible portions of organisms [43 CFR § 11.62(f)(1)(ii)]
- exceed levels for which an appropriate State health agency has issued directives to limit or ban consumption of such organism [43 CFR § 11.62(f)(1)(iii)]
- cause the biological resource or its offspring to have undergone at least one of the following adverse changes in viability: death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), or physical deformations [43 CFR § 11.62(f)(1)(i)].

Regulations promulgated pursuant to the federal Food, Drug and Cosmetics Act (Section 402, 21 U.S.C. 342) and fish consumption guidelines established by the Michigan Department of Public Health (DPH)[1] set an action or tolerance level of 2 mg/kg total PCBs in edible portions of fish tissue.

1. As of April 1, 1996, pursuant to Executive Order 1996-1, the functions of the Michigan DPH were divided among the Michigan DEQ, the Commerce Department, and the Department of Community Health.

Exceedence of Federal and State Tolerance Level in Fish Fillets

Data presented in Section 3.3.4 show that PCB concentrations in the fillets of Portage Creek and Kalamazoo River fish exceed the 2.0 mg/kg tolerance level threshold. For example, in the 1993 Portage Creek mark-recapture study, the mean PCB concentration in carp fillets, 3.4 mg/kg, greatly exceeded the tolerance level. The maximum PCB concentration, 8.8 mg/kg, was over four times greater than the tolerance level. Sixty-four percent of the carp collected from Portage Creek in 1993 contained fillet PCB concentrations greater than 2.0 mg/kg, and another 18 percent contained PCB fillet concentrations equal to 2.0 mg/kg (Table 4-2; Blasland, Bouck & Lee, 1994b).

Table 4-2
Percent of Carp and Smallmouth Bass Fillets that Exceeded the 2.0 mg/kg PCBs Injury Threshold, Kalamazoo River and Portage Creek, 1993

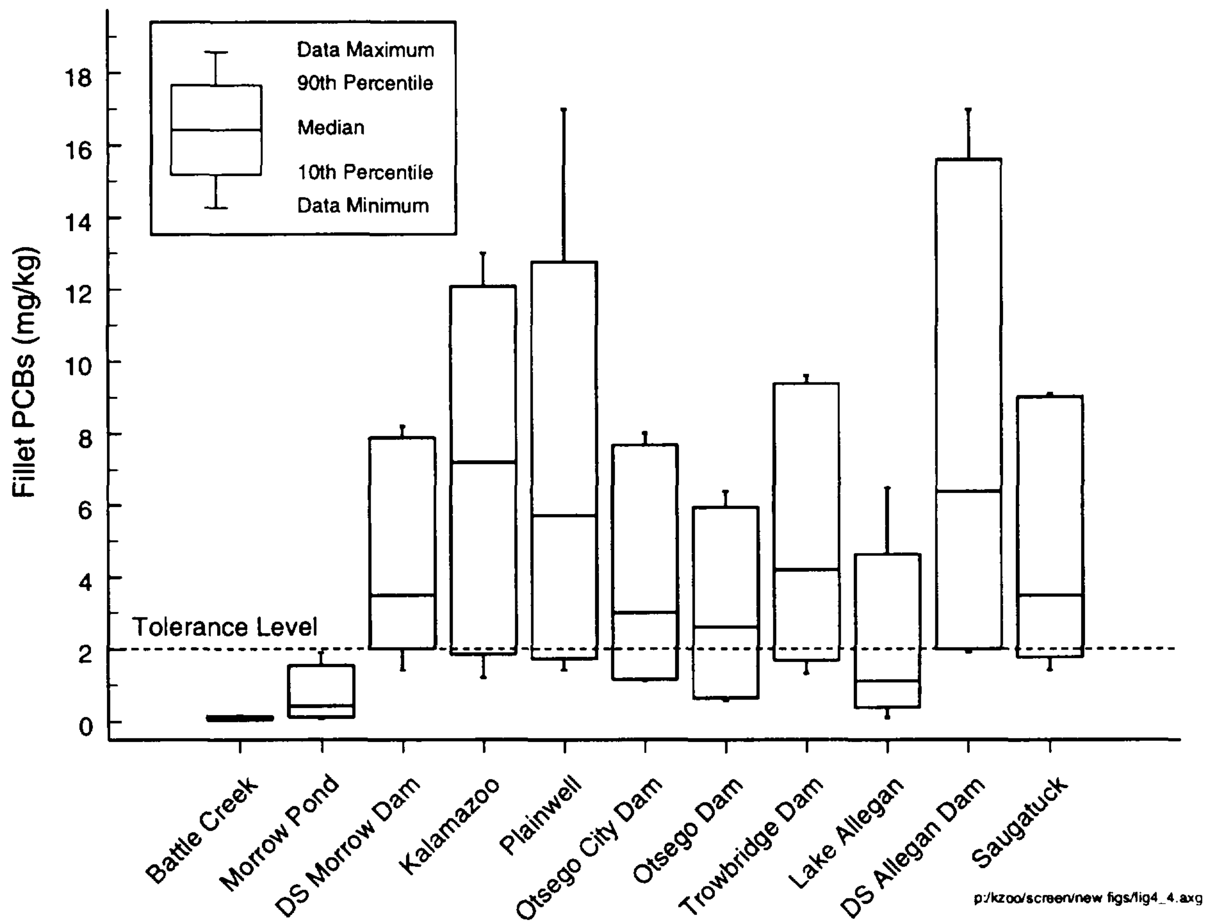
Location	n	Carp	Smallmouth Bass
Upstream of Battle Creek (upstream of PRP facilities)	11	0%	0%
Morrow Pond (upstream of PRP facilities)	11	0%	0%
Portage Creek	11	73%	—
Downstream of Morrow Pond Dam	11	91%	9%
City of Kalamazoo	11	91%	0%
Downstream of Plainwell	11	91%	27%
Between Plainwell Dam and Otsego City Dam	11	55%	9%
Upstream of Otsego Dam	11	55%	18%
Upstream of Trowbridge Dam	11	91%	36%
Lake Allegan	11	27%	82%
Downstream of Allegan Dam	11	91%	55%
Saugatuck	11	91%	0%

n = Number of samples.

Source: Blasland, Bouck & Lee, 1994a, 1994b.

In the Kalamazoo River in 1993, over 75% (75 of 99) of the carp collected downstream of the Morrow Pond Dam contained fillet PCB concentrations in excess of 2.0 mg/kg (Table 4-2; Blasland, Bouck & Lee, 1994a). Figure 4-4 shows the marked increase in carp fillet PCB concentrations from downstream of the Morrow Pond Dam to the mouth of the Kalamazoo River at Saugatuck relative to upstream concentrations. Upstream of PRP facilities (Battle Creek and Morrow Pond), 0% of the carp fillets contained PCBs at concentrations greater than 2.0 mg/kg.

Figure 4-4
PCB Concentrations in Kalamazoo River Skinless Carp Fillets, 1993

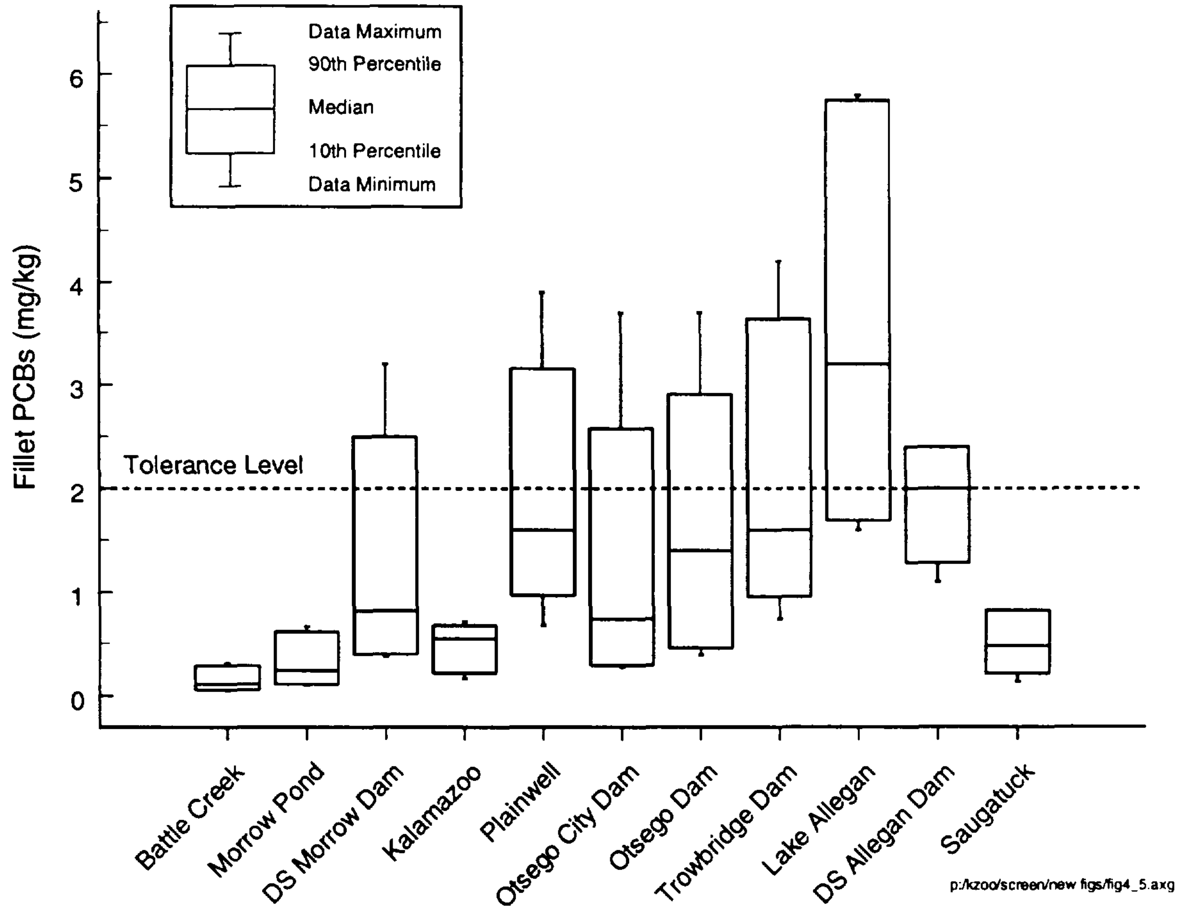


Downstream is to the right. Battle Creek and Morrow Pond locations are upstream of PRP facilities. The horizontal dotted line is the FDA tolerance and State fish consumption advisory action level of 2 mg/kg. Sample size at all sites is 11 carp.

At the 9 sampling locations downstream of PRP facilities, from 27% to 91% of the carp fillets exceeded 2.0 mg/kg PCBs. The maximum PCB concentration measured in carp fillets, 17 mg/kg, exceeded the action level by over eight times.

Smallmouth bass in the Kalamazoo River also contained PCBs in excess of the 2.0 mg/kg threshold (Blasland, Bouck & Lee, 1994a). From Plainwell to downstream of the Allegan Dam, 38% (25 of 66) of smallmouth bass collected contained PCB fillet concentrations in excess of 2.0 mg/kg (Figure 4-5). Maximum PCB concentrations in smallmouth bass fillets were nearly 6 mg/kg, three times the injury threshold. In contrast, 0% of smallmouth bass fillets from upstream of PRP facilities contained greater than 2.0 mg/kg PCBs.

Figure 4-5
PCB Concentrations in Kalamazoo River Skin-On Smallmouth Bass Fillets, 1993



Downstream is to the right. Battle Creek and Morrow Pond locations are upstream of PRP facilities. The horizontal dotted line is the FDA tolerance and the State fish consumption advisory action level of 2 mg/kg. Sample size at all sites is 11 bass.

Adverse Effects on Fish Viability

PCBs can adversely affect fish viability by causing mortality, decreased reproductive success, and increased incidence of fry deformities (Eisler, 1986). Other documented effects of PCBs on fish include edema, hemorrhages, arrested growth and development, liver enlargement, calcium, magnesium, and cholesterol metabolism disruption, decreased coordination, anemia, and hyperglycemia (Eisler, 1986; Peterson et al., 1993).

PCBs can also cause additional adverse biochemical, immunological, histopathological, and physiological effects in fish. Many of the adverse effects of PCBs are mediated by the aryl hydrocarbon (Ah) receptor (Safe, 1994; Hahn et al., 1994). In fish, a sensitive biological indicator of Ah receptor activation by PCBs is the induction of liver detoxication enzymes such as cytochrome P4501A1 (Stegeman and Hahn 1994). Associated with this induction is altered immune function (Rice and Schlenk, 1995; Arkoosh et al., 1994), increased promotion of liver tumors (Hendricks et al., 1981; Hendricks et al., 1990), altered vitamin A metabolism and storage (Gilbert et al., 1995; Ndayibagira et al., 1995), and altered estrogen action on target organs such as the liver (Anderson et al., 1996).

PCBs can interfere with normal reproductive function in fish by reducing sex hormone levels (Thomas, 1988), impairing ovarian maturation (Monosson et al., 1994), or impairing testes maturation (Freeman and Idler, 1975; Sangalang et al., 1981). Hepatic metabolites of PCBs have also been shown to be estrogenic in fish (Flouriot et al., 1995). Persistent estrogenic compounds can cause an inhibition of testicular growth in male fish, and deleterious reproductive consequences may occur as a result (Jobling et al., 1996).

Fish in early life stages are more sensitive to PCB toxicity than adults (Eisler, 1986). Adverse effects such as reduced egg hatchability, fry mortality, and developmental deformities occur at PCB concentrations that are orders of magnitude lower than concentrations causing adult mortality (Nebeker et al., 1974; Eisler, 1986). Fish embryos can acquire PCB burdens both by uptake from water and maternal transfer during oogenesis (Broyles and Noveck, 1979; Niimi, 1983; Ankley et al., 1989; Noguchi and Hesselberg, 1991; Spitsbergen, 1991, as cited in Walker and Peterson, 1991). In the embryo, PCBs accumulate in the lipid-rich yolk to concentrations that are typically much greater than those in the surrounding water (Broyles and Noveck, 1979) and possibly greater than those in the maternal fish (Niimi, 1983). Many of the adverse effects of PCBs on fry occur during yolk sac absorption, suggesting that the toxicity of PCBs to early life stages is associated with uptake of PCBs from the yolk sac by the developing embryo (Mac, 1988; Harris et al., 1994).

Hogan and Brauhn (1975) report that rainbow trout eggs containing 2.7 mg/kg Aroclor 1242 had 75% mortality in the first 30 days after hatching, compared with 10-28% mortality in eggs containing much lower concentrations (actual PCB concentrations not reported). Johansson (1970, as cited in Niimi, 1983) reported 46-100% mortality in eggs and fry of Atlantic salmon (*Salmo salar*) containing PCB concentrations from 0.6 to 1.9 mg/kg. Mac and Schwartz (1992) and Mac et al. (1993) found a negative correlation between egg PCB concentrations and egg hatchability in lake trout (*Salvelinus namaycush*), although no statistics were performed to define no-effect and lowest-effect PCB concentrations. Decreased hatching success generally appeared to be associated with egg PCB concentrations greater than 2.0 mg/kg. Similarly, Ankley et al. (1991) found an inverse relationship between total PCB concentrations in chinook salmon (*Oncorhynchus tshawytscha*) eggs and egg hatchability, with decreased hatching success apparently associated with egg PCB concentrations greater than approximately 3 mg/kg.

Niimi (1983) has shown that total PCB concentration in the eggs of various fish species are 43% to 120% of the whole body total PCB concentration in the maternal fish. Several species of fish from Portage Creek and the Kalamazoo River contain PCBs often in excess of 10 mg/kg whole body (Michigan DNR, 1992; Blasland, Bouck & Lee, 1994a; see Section 4.3.4, Figures 4-4 and 4-5). In 1993, whole-body PCB concentrations in some carp from the Kalamazoo River exceeded 20 mg/kg (Blasland, Bouck & Lee, 1994a). Using the maternal fish-to-egg ratios observed by Niimi (1983), the eggs from a fish containing 10 mg/kg PCB could contain PCB concentrations of 4.3 mg/kg to 12 mg/kg. Assuming that adverse effects occur at egg total PCB concentrations greater than 2-3 mg/kg, these data show that PCB concentrations in Portage Creek and Kalamazoo River fish are sufficient to potentially cause injury by causing adverse effects on fish viability. Other adverse effects, as described above, may also be occurring.

4.3.5 Wildlife

Relevant definitions of injury to wildlife include the following:

- tissue concentrations in edible portions exceeding action or tolerance levels established by Section 402 of the Food, Drug and Cosmetic Act (21 U.S.C. 342) or an appropriate State health agency [43 CFR § 11.62(f)(1)(ii), (iii)]

- concentrations of the released hazardous substance sufficient to cause adverse changes in viability, including death, disease, behavioral abnormalities, physiological malfunctions (including reproductive malfunctions), or physical deformations [43 CFR § 11.62(f)(1)(i)].

Regulations promulgated pursuant to the federal Food, Drug and Cosmetics Act (Section 402, 21 U.S.C. 342) establish an action or tolerance level of 3 mg/kg PCB in poultry fat and red meat fat [21 CFR § 109.30]. To evaluate potential injury to wildlife, this tolerance level may also be applied to edible portions of wildlife hunted recreationally, including waterfowl (ducks and geese).

Exceedences of Federal Action Level in Waterfowl Fat

PCB concentrations measured in waterfowl lipids (or fat) have exceeded the 3.0 mg/kg federal action level in, 14 mallards (of 15 sampled), one wood duck (of two sampled), and in one merganser, one Canada goose, and one blue-winged teal (only one individual sampled for each of those three species) from the KRE (Blasland, Bouck & Lee, 1992; Michigan DNR, 1987a; Michigan Department of Public Health, 1990; see Section 3.3.4, Table 3-5 of this document). The PCB concentration in the fat of the merganser was 700 mg/kg (Michigan DNR, 1987a), over 230 times greater than the 3 mg/kg action level.

Adverse Effects on Wildlife Viability: General

PCBs can cause numerous toxic effects in mammals and birds, including adverse impacts on endocrine, neurological, immunological, and organ systems (Peterson et al., 1993; Safe, 1994). In both mammals and birds, the embryo/fetus is generally more sensitive to PCBs than are adults. PCBs can be deposited in bird eggs during oogenesis and transferred across the placenta in mammals. Prenatal exposure to PCBs can cause embryo mortality and a range of developmental abnormalities, including cleft palate, hydronephrosis, kidney anomalies, and edema. Other effects resulting from prenatal exposure include androgenic effects such as decreased androgen, decreased size of androgen-dependent structures (e.g., decreased epididymis weight), decreased spermatogenesis, demasculinization of sexual behaviors, and feminization of luteinizing hormone secretion regulation (Peterson et al., 1993; Safe, 1994).

In adult mammals and birds, female reproductive systems are generally the most sensitive endpoints to PCB toxicity (Peterson et al., 1993; Safe, 1994). Effects include reduced fertility and reduced litter size at concentrations less than those that cause adult mortality. Anti-estrogenic effects also occur, including inhibition of the estrous cycle and decreased levels of estrogen and progesterone (Eisler, 1986; Peterson et al., 1993).

Adverse Effects on Wildlife Viability: PCB in the Diet

Dietary PCBs have been shown to cause adverse effects on wildlife viability. While there are no regulations promulgated for PCB concentrations in prey items, data from the literature provide a basis for evaluating potential injuries in predatory birds and mammals.

Several laboratory studies have determined concentrations of PCBs in mink diet likely to cause adverse effects on viability. Most of these studies are reviewed by Wren (1991) and Ludwig et al. (1993). Based on these laboratory data, and conservative estimates that PCB-contaminated Kalamazoo River fish constitute 33% of a mink diet (U.S. EPA, 1993)[2] and that the other 67% of mink diet is not contaminated with PCBs, the approximate threshold at which whole-body PCBs in Kalamazoo fish would cause injury to mink is 2.4 mg/kg.

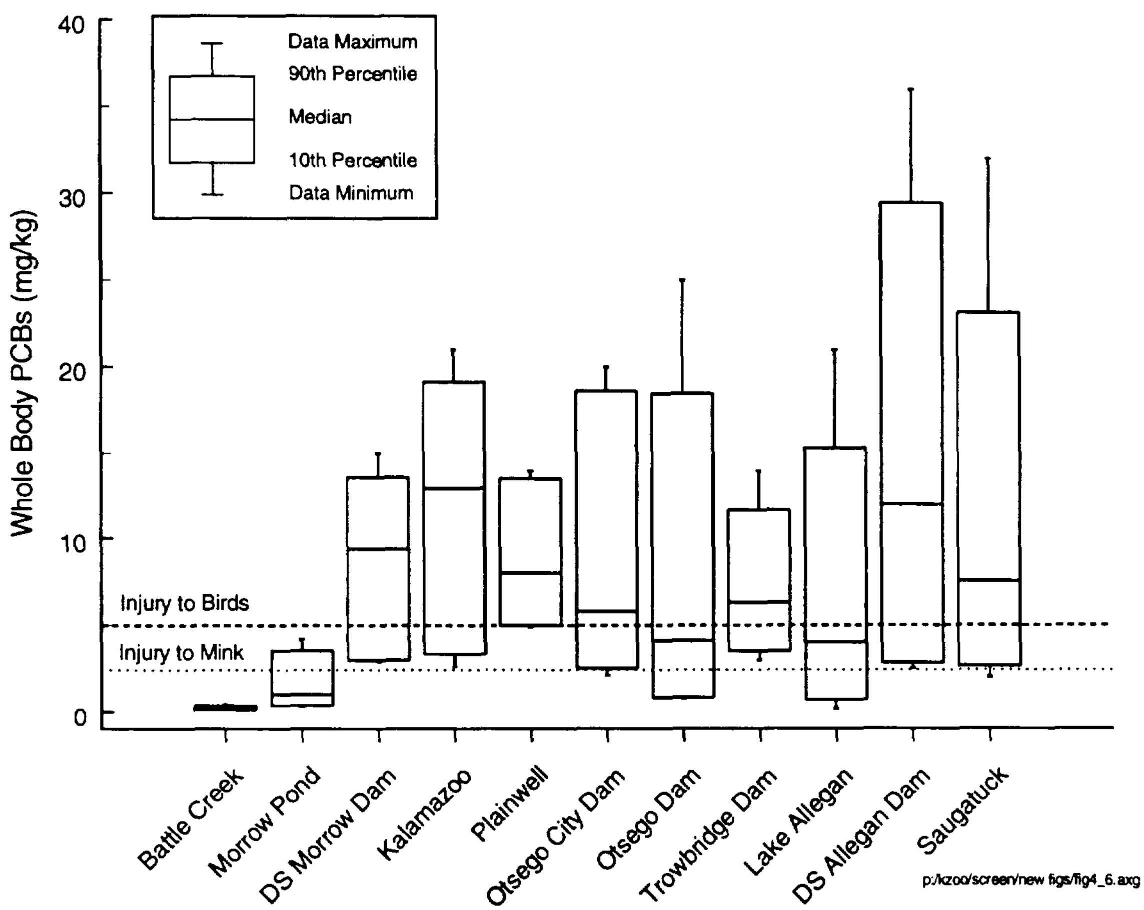
Studies on dietary PCB toxicity to birds include those conducted on chickens, doves, American kestrel (*Falco sparverius*), and ring-necked pheasant (*Phasianus colchicus*) (Lincer and Peakall, 1970; Peakall, 1972; Britton and Huston, 1973; Platonow and Reinhart, 1973; Lillie et al., 1974, 1975; Scott, 1977; Roberts et al., 1978; Bird et al., 1983; Tori and Peterle, 1983). These studies indicate that dietary PCBs cause adverse effects when concentrations are greater than

2. Studies of mink diet composition in Michigan presented in U.S. EPA (1993) range from 4% fish (by stomach content volume) to 85% fish (by stomach content wet weight). An estimate of 90% of the diet being comprised of fish is used in establishing wildlife criteria in 40 CFR § 132. A mink diet consisting of 33% fish is used as a conservative estimate for the purposes of this Preassessment Screen.

approximately 5 mg/kg in the diet. For the purposes of comparison, it has been assumed that the diet of piscivorous birds such as bald eagles and great blue herons consists of 100% KRE fish. Thus, whole-body fish PCB concentrations in excess of 5 mg/kg would be likely to cause adverse effects to obligate piscivorous birds in the KRE.

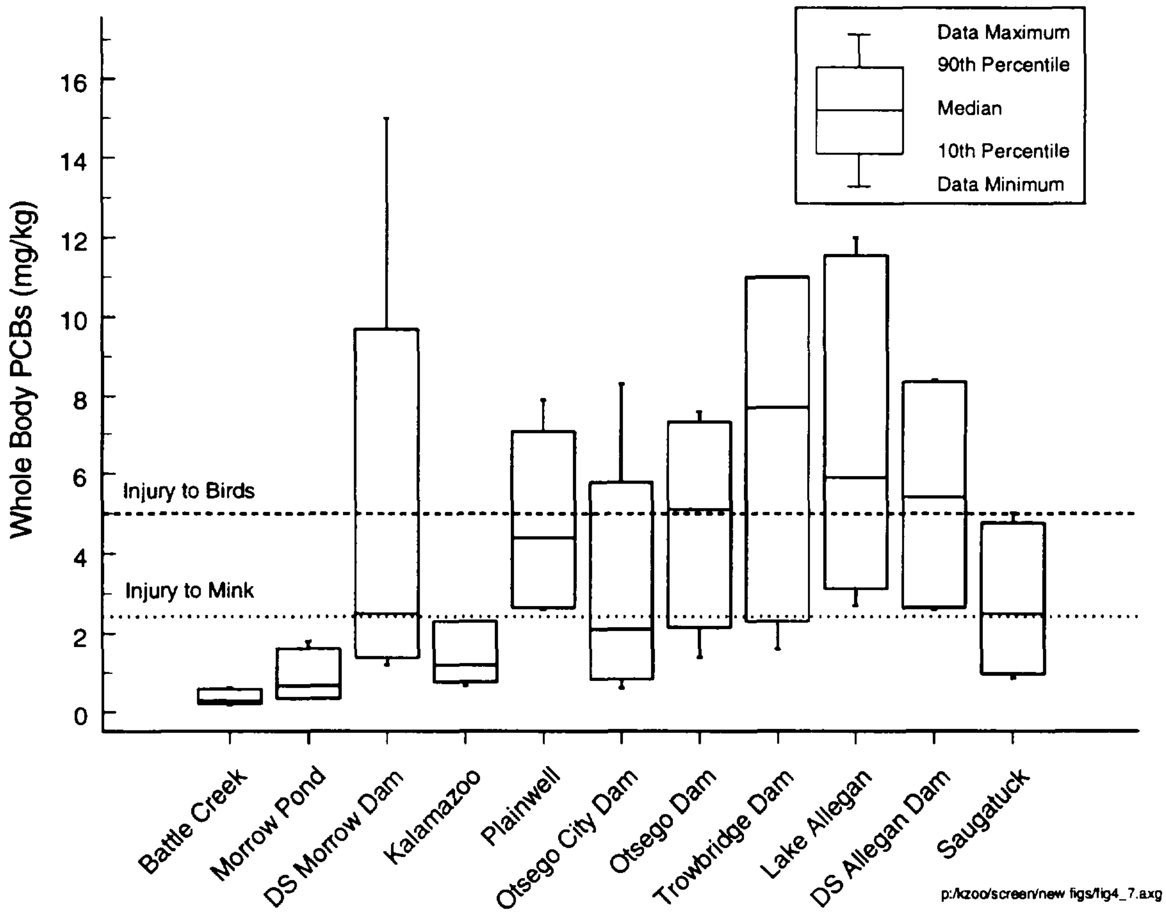
Whole-body PCB concentrations in fish were measured as part of the RI/FS in 1993. Data for Kalamazoo River carp and smallmouth bass are shown in Figures 4-6 and 4-7, respectively.

Figure 4-6
Whole-Body PCB Concentrations in Kalamazoo River Carp Measured in 1993 Compared with Concentrations Sufficient to Potentially Cause Injury to Piscivorous Wildlife



Downstream is to the right. Battle Creek and Morrow Pond locations are upstream of PRP facilities. Sample size at all sites is 11 carp. Fish concentration data are from Blasland, Bouck & Lee (1994a).

Figure 4-7
Whole-Body PCB Concentrations in Kalamazoo River Smallmouth Bass Measured in 1993 Compared with Concentrations Sufficient to Potentially Cause Injury to Piscivorous Wildlife



Downstream is to the right. Battle Creek and Morrow Pond locations are upstream of PRP facilities. Sample size at all sites is 11 bass. Fish concentration data are from Blasland, Bouck & Lee (1994a).

Included in the figures is the 2.4 mg/kg PCB concentration conservatively estimated to be the lowest concentration in fish tissue likely to result in injuries to mink, and the 5 mg/kg threshold for injuries to birds.

Figures 4-6 and 4-7 show that PCB concentrations in whole bodies of carp and smallmouth bass from downstream areas are higher than the estimated threshold levels for potentially causing injury to mink and birds.

Median whole-body PCB concentrations in carp exceeded the thresholds at most sampling locations downstream of PRP facilities in 1993, including downstream of Lake Allegan (Figure 4-6). Median whole-body PCB concentrations in smallmouth bass exceeded the mink threshold at most locations and exceeded the bird dietary threshold at four locations (Figure 4-7). These data indicate that downstream of PRP facilities, Kalamazoo River fish contain PCBs at concentrations sufficient to potentially cause injury to piscivorous mammals and birds.

Adverse Effects on Wildlife Viability: PCBs in Mink Livers

Various laboratory studies have shown that PCB exposure causes adverse effects on the viability of mink. PCB concentrations in mink livers associated with mortality or adverse reproductive effects have been measured at approximately 2 mg/kg (wet weight) (Wren et al., 1987; Heaton, 1992; Tillitt et al., 1996). This concentration equals approximately 7 mg/kg dry weight, assuming approximately 70% moisture content (Heaton, 1992). In 1993, the Michigan DNR collected 10 mink from five locations along the Kalamazoo River and analyzed each of the carcasses and livers for PCBs (CDM, 1993; Roy F. Weston Inc., 1994). These data show that mink collected from PCB-contaminated areas downstream of paper company facilities (near Trowbridge, Plainwell, and Allegan dams) contained higher concentrations of PCBs than mink from upstream areas, with PCB concentrations in downstream areas as high as 52.0 mg/kg (dry weight) (see Table 3-10). All of the liver PCB concentrations measured in mink from areas downstream of PRP facilities were greater than the 7 mg/kg associated with mink toxicity in laboratory studies. These data provide additional evidence that KRE mink are exposed to PCBs at concentrations sufficient to potentially cause injury.

Adverse Effects on Wildlife Viability: PCBs in Bird Eggs

PCB concentrations in the eggs of piscivorous birds provide additional information for evaluating injuries. Several studies have analyzed the threshold PCB concentrations in bird eggs that result in gross adverse effects on egg viability (e.g., egg lethality). Egg PCB threshold concentrations are available for chickens (Britton and Huston, 1973; Platonow and Reinhart, 1973; Lillie et al., 1975; Scott, 1977; Brunstom, 1988), gulls (Ludwig et al., 1993), terns (Kubiak et al., 1989; Yamashita et al., 1993), cormorants (Tillitt et al, 1992), and bald eagles (Kubiak et al., 1991). Most of these studies conclude that adverse effects occur when PCB concentrations are in the range of 1-5 mg/kg, although inter-species differences in sensitivity are likely.

PCB concentrations in great blue heron and bald eagle eggs are well above the 1-5 mg/kg range (Mehne, 1994, 2000; see Table 3-6). A bald eagle egg collected in 1994 from Ottawa Marsh contained 102 mg/kg PCBs (D. Best, U.S. Fish and Wildlife Service, pers. comm., 1999), two orders of magnitude greater than the lower adverse effects threshold. Two bald eagle eggs collected from the nest in the Allegan State Game Area in 1996 contained 31.7 and 53.3 mg/kg PCBs (D. Best, U.S. Fish and Wildlife Service, pers. comm., 1999). The egg data for great blue herons also suggest that impacts may be occurring to this piscivorous species. Egg PCB concentrations measured in 1993 ranged from 1.48 mg/kg to 44.38 mg/kg (Mehne, 1994). Thus, although the data are limited, PCB concentrations in KRE bald eagle and great blue heron eggs have exceeded concentrations reported in the literature to cause adverse effects.

A pair of bald eagles have attempted to nest in the Ottawa Marsh from 1990 through 1999. No young have been produced from this nest, except in 1998 when two young were fledged (D. Best, U.S. Fish and Wildlife Service, personal communication, 2000). A second pair of eagles nested in the Highbanks Game Refuge in the Allegan State Game Area from 1993 through 1999. The eggs failed to hatch every year except for 1999, when two fledglings were produced. Between the two territories, the eagles have successfully produced young in only two of 17 nesting attempts.

PCB concentrations in great horned owl and red-tailed hawk eggs from 1993 and 1994 (Mehne, 1994; see Table 3-7) were also sufficient to potentially cause injuries. PCB concentrations measured in the two great horned owl eggs collected from the Allegan State Game Area were 15.94 mg/kg and 90.8 mg/kg; (see Table 3-7). A red-tailed hawk egg collected from the Allegan State Game Area in 1993 contained 2.31 mg/kg PCB, and two eggs collected in 1994 contained 4.47 and 27.12 mg/kg (see Table 3-7). These data confirm that great horned owls and red-tailed hawks in the Kalamazoo River are accumulating PCBs, and suggest that the accumulation is sufficient to potentially cause adverse reproductive effects.

4.3.6 Summary

Based on a "rapid review of readily available information" [43 CFR § 11.23(b)], the Trustees conclude that the quantity and concentration of the released hazardous substance are sufficient to potentially cause injury to Trustee natural resources, including surface water, groundwater, geological, and biological resources.

4.4 DATA SUFFICIENT TO PURSUE AN ASSESSMENT ARE AVAILABLE OR LIKELY TO BE OBTAINED AT REASONABLE COST

Data relevant to conducting an assessment of natural resource damages in the KRE have been collected as part of ongoing RI/FS activities (e.g., Blasland, Bouck & Lee, 1994a-h). Such data include information on PCB sources, releases, pathways, and concentrations in the environment. As the Preassessment Screen is intended only to determine whether there is sufficient cause to pursue an NRDA, omission of any information in the Preassessment Screen does not preclude consideration of such information in the course of an NRDA. Additional data for the purposes of performing a damage assessment are expected to be obtainable at reasonable cost.

4.5 RESPONSE ACTIONS WILL NOT SUFFICIENTLY REMEDY THE INJURY TO NATURAL RESOURCES WITHOUT FURTHER ACTION

PCBs are relatively stable compounds, and chemical degradation under environmental conditions is very slow (MacKay et al., 1992). However, some microbial degradation does occur; the rate of microbial degradation depends in part on the degree of chlorination and the position of the chlorine atom on the biphenyl molecule (Rhee et al., 1993). Available data indicate that surface water/sediments, soils, groundwater, and biological resources throughout the KRE downstream of PRP facilities are contaminated with PCBs, as discussed in Chapter 3. Response actions being formulated as part of the RI/FS most likely will not restore to baseline the services provided by the injured natural resources or address past or interim losses of natural resource services.

4.6 CONCLUSIONS

Based on an evaluation of the preassessment determination criteria, the following conclusions can be made:

- A release of hazardous substances has occurred.
- Natural resources for which the Trustees have trusteeship have been or are likely to have been adversely affected.
- The quantity and concentration of the released hazardous substances are sufficient to potentially cause injury.
- Data sufficient to pursue an assessment are readily available or likely to be obtained at reasonable cost.
- Response actions will not sufficiently remedy the injury to natural resources without further action.

Based on an evaluation of these five criteria, the Trustees have determined that a NRDA should be performed to assess damages to natural resources caused by releases of PCBs from PRP facilities to the Kalamazoo River environment.

CHAPTER 5
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